International Marine Engineering

VOLUME XVIII

JANUARY TO DECEMBER, 1913

PUBLISHED BY
ALDRICH PUBLISHING CO.
(INCORPORATED)
17 BATTERY PLACE, NEW YORK, U. S. A.
31 CHRISTOPHER STREET FINSBURY SQUARE, LONDON, E. C.

INDEX.

NOTE.—Illustrated articles are marked with an (*) asterisk

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JANUARY, 1913

Lighthouses and Buoys of New York Harbor

BY JAMES PATTISON

With the opening of Ambrose channel, the subject of lighthouse illumination of New York harbor has received most careful attention. Less than a decade ago the ocean entrance from the lower to the upper bay was crooked and narrow and beset with treacherous shoals through which only the most skillful and experienced pilots could navigate with safety. Ocean traffic to this port was steadily growing, and each year witnessed vast increases in the size and speed of vessels, with no apparent limitation in sight. Formerly the only sources of light for lighthouses were oil and oil gas, the former burned in a wick, the latter with a flat flame; both were feeble and of very limited range. But to-day conditions are different. The great liner making the port of New York at night is now guided by the powerful rays of the electric arc, the acetylene flame, and the incandescent light of Pintsch gas, and petroleum vapor. A broad, straight and deep channel now pierces the shoals of the lower bay, through which the ocean greyhound may pass with unabated speed to the safety of the upper bay.

FIG. 1.—SENTINELS OF THE SEA

Modern Aids to Navigation

The aids to navigation in New York Bay, which will be briefly described, comprise lighthouses whose source of illumination is electricity or oil vapor; beacons; combined lighted acetylene and warning buoys; combined lighted Pintsch gas and warning buoys; automatic whistling and bell buoys; conical and tubular buoys of large size; spar buoys and can and nun buoys of various sizes. Other aids are lightships, submarine warning stations and wireless telegraph stations.

Light Signals

The lighted aids have distinctive characteristics, viz., fixed lights, revolving lights and flashing lights. The single fixed light as established at Sandy Hook light station and Conovar beacon light station, consists of an oil vapor light within a fixed or stationary drum lens. (For fixed range lights a bullseye or holophoto is used.)

The revolving lights, such as Navesink light station and Nomer Shoal light station, are employed only for large lights of the first, second, third and fourth orders, and are equipped with lenses sometimes of the most wonderful and complicated construction, to produce flashes of different durations and intensities. The lens is supported on a table or float, which is revolved around the light in a bath of mercury by means of a falling weight or spring clock.

The flashing light is used on buoys and beacons and is produced by the pressure of the illuminating gas (acetylene or Pintsch gas) upon a flexible bellows or diaphragm, which operates a valve or valves controlling the flow of gas to the burner. A tiny pilot burner maintains a light at all times and intermittently lights the main flame as gas escapes with each impulse of the diaphragm. Thus light and dark intervals are produced.

Fixed drum lenses are also used with this system and vary in diameter from 8 to 15 inches. Unaided, the naked light would not carry far and its beams would be diffused and scattered in all directions. Therefore, one of the subjects which received the earliest attention was the means for collecting and concentrating the light rays and projecting them in a horizontal plane. For this purpose two systems were developed, the first being the Caloptric or reflector system, now almost obsolete, the second the Droptic or lens system, used to-day in all modern lighthouses and buoys. In passing, it may be of interest to note that all cut-glass lenses used in the lighthouse and buoys of the United States are made in Germany, France or England, and that all attempts (and many have been made) to manufacture them in this country have failed.

Increase in Light Power

The increases in intensity of light due to the use of new illuminants are very high. For example, by substituting an oil-vapor burner for a circular wick burner of the same diameter the power of an apparatus is increased about three and one-half times. The increase in power of the electric arc over the circular wick burner is still greater, but the use of electricity is still attended with too many disadvantages to permit its general extension to lighthouse illumination. The gain in lighting power of acetylene over oil gas (flat flame) is about 4 to 1, acetylene producing 45 candles per foot, oil gas 11. The gain in the lighting power of oil gas (Pintsch gas) burned in an incandescent mantle, over the flat flame, is also about 4 to 1. These increases in light power have all been effected within the last decade.

Sound Signals

Of the sound signals used as aids to navigation in New York harbor, the most common types are the bell buoys and whistling buoys, both of which are frequently combined with light signals—e. g., the Ambrose channel entrance buoy is of the latter type (combination light and whistle), as shown in Fig. 8.

The whistle on these buoys is sounded by the action of the waves on what is known as the Courtenay principle. A long tube descending from the buoy body has an area of about 7 square feet, and extends to the top of the body or flotation chamber. One or two smaller tubes connect from it to the whistle valve, which is provided with solid rubber balls, making a tight seat. The whistle, which varies from 8 inches to 12 inches in diameter, is fastened to the valve and protected by the superstructure which carries the lantern. As the buoy rises on a wave air is sucked in through the valve, and as the buoy descends is compressed and forced violently through the whistle, producing a loud moaning noise.

The bell buoys are familiar to everyone who sails down the bay. The trinity type with four hanging tappers is the most usual form. This type is illustrated in Fig. 4, where it is being taken in to be cleaned and painted.

The Ambrose channel light vessel is equipped with a 12-inch steam whistle, which sounds a blast every fifteen seconds in foggy weather. North Hook beacon and Old Orchard Shoal light stations are equipped with automatic compressed air sirens, while Nomer Shoal light station has a bell which is operated by machinery, striking once every thirty seconds. A similar bell signal is installed at Coney Island light station.

Fig. 2.—Collection of Buoys at Lighthouse Depot

A Trip Down the Harbor

Having thus briefly described the various kinds of modern light and sound signal apparatus employed in New York harbor, the reader is invited in fancy for a trip on the lighthouse tender to the lightships, and returning up the Ambrose channel, will have each of the important light stations pointed out in the order they appear to the incoming navigator.

We embark at the General Lighthouse Depot, Tompkinsville, S. I., where the work of loading on supplies is proceeding. The powerful derrick of the tender picks up a ten-ton steel buoy from the dock and places it gently on the forward deck. Then follow two gas tanks, each weighing 1,500 pounds and containing a supply of acetylene sufficient to maintain the buoy lighted for six months or a year without interruption. The huge buoy lantern, weighing one-fourth of a ton, is then swung aboard.

Soon we are under way, and reaching the station where the big A G A buoy is to be placed, the captain sings out his orders and the anchor plunges down to the music of chains rattling through the hawse pipe. The buoy is lifted from the deck and lowered into the water, where it is anchored to a cast iron sinker of hemispherical form or a square block of concrete containing iron punchings to give it additional weight, or perhaps an ordinary anchor, depending upon the nature of the bottom and the force of the currents. The buoy afloat, a couple of deck hands mount on it and remove the covers from the tank pockets, the tanks are lowered into place, and the gas piping coupled up, after which the covers are replaced. The lantern is then lifted on to the top of the framework, more than 16 feet above the water, and bolted down. The gas piping is coupled up and joints are tested for leaks with soapsuds. The valves are then opened and a match is applied to the burner. Soon the anchor is weighed and the tender gets under way again, heading for the upper Pintsch buoy at Gedney channel.

The pressure gage on this buoy indicates the need of a fresh charge of gas. The gas used on these buoys is made from crude oil at a station on shore, and is pumped into small steel containers or bottles to a pressure of 100 atmospheres, so that it is easily transported to the buoys. To charge the buoy a high-pressure hose is coupled between the tank and the buoy and the gas is allowed to flow in until it attains a pressure in the buoy of 12 atmospheres. This operation is being performed in the picture shown in Fig. 9.

The modern Pintsch gas buoy light employs a spherical incandescent mantle in which the gas is burned at 1 pound pressure, producing a light of 40 candles per foot, as compared with less than 12 candles with the old style of burner with naked flame. The average life of mantles on buoys taken from over 2,000 buoys is said to be three months. Fig. 5 illustrates a Pintsch mantle being renewed.

At length the Ambrose channel lightship is reached, and after transferring supplies we prepare for the return trip to the depot.

The Ambrose channel lightship is a straw-colored vessel with two masts and one funnel which also carries the steam fog whistle. It is equipped with wireless. On the foremast is carried a lantern containing an electric arc light, which shows a flashing light of 12 seconds duration, followed by eclipses of 3 seconds. This light is visible 13 miles. She carries a crew of about 15 men.

The next light visible is the great gas and whistling buoy at the intersection of the Gedney and Ambrose channels. This buoy is known as the Willson buoy, and employs acetylene as an illuminant. Its characteristic is 5 seconds light, followed by an eclipse of 5 seconds. The gas is generated from calcium carbide within the buoy itself. The generating chamber contains about 3,000 pounds of carbide at a charge, and as this carbide is capable of producing 4½ cubic feet of acetylene per pound, there is altogether available 13,500 cubic feet of gas, sufficient to keep the buoy lighted for a year or more. Calcium carbide is made by fusing together a mixture of coke and lime in an electric arc furnace. When broken up it resembles granite rock. Acetylene produces a light of great brilliancy, comparable only to sunlight.

Away on the port side is seen the quick, blinding flash of Navesink light station, an electric arc light with a first-order lens, producing a light of more than 1,000,000 candles, visible at 22 miles. This type of light station is termed a landfall light.

The range lights on Staten Island now come in view. These are high-power incandescent oil-vapor lights. The in-

FIG. 3.—LIGHTHOUSE TENDER TULIP

FIG. 4.—PICKING UP AN OLD BELL BUOY

candescent oil-vapor light is steadily replacing the oil lamp with circular wick. It gives a light of many times greater power with a smaller consumption of oil. Briefly, it consists of a small oil tank connected to a smaller air tank, in which air is compressed by a hand pump to a pressure of about 60 pounds per square inch. The oil is forced through a very fine tube to the vaporizer in the burner, where it is vaporized and burned in a mantle. The mantles vary from 1⅜ inches to 2⅛ inches in diameter, and from about 4 to 6 inches long. The light produced is dazzlingly white. Incandescent oil vapor burners are now used in all large modern lighthouses. The front range is equipped with a fog signal known as a Daboll trumpet.

We now enter the Ambrose channel, which is guarded at its entrance by an A G A combination light and whistling buoy. This buoy is on the port side and has a white light with the following characteristics: two-tenth second light, followed by four-tenth second eclipse. As we pass the dismal howl of the whistle may be heard. As previously described, this type of buoy is provided with tanks containing dissolved acetylene.

These tanks or steel bottles are filled with an earthy porous mass of about 80 percent porosity, which precludes the spreading of an explosion wave. This mass is saturated with acetone, a liquid hydrocarbon possessing the remarkable property of absorbing 25 times its own volume of acetylene for each atmosphere of pressure, so that a bottle 22 inches in diameter by 70 inches long contains at 10 atmospheres about 1,100 cubic feet of gas. This gas passes up into the lantern, where it is reduced in pressure to the fraction of a pound, after which it enters the flasher and the burner.

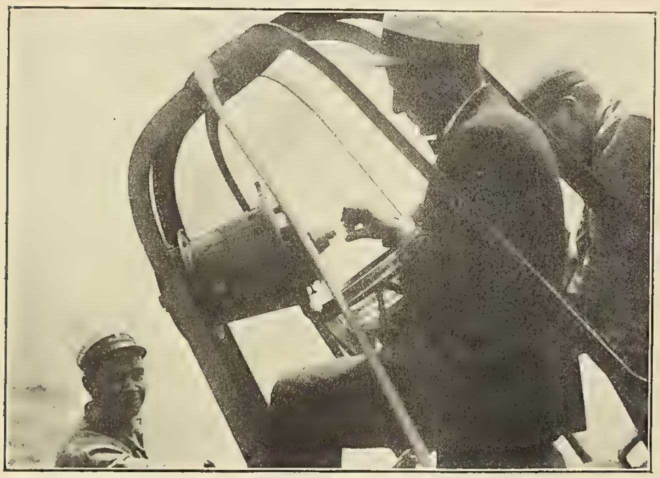

FIG. 5.—PUTTING MANTLE ON LAMP OF PINTSCH GAS BUOY

To the starboard we pass a Pintsch gas buoy with fixed red light; then alternately to port and starboard white and red buoy lights are passed, the red always on the starboard and the white on the port. Nun buoys (conical) are usually placed on the starboard side and can buoys (cylindrical) on the port.

Buoy after buoy is passed, and we soon leave behind the lights on the inner range of Sandy Hook. Away to the port we passed Old Orchard Shoal light station with its light visible 13 miles. Its fog signal is operated by compressed air from a small compressor run by a gasoline (petrol) engine. It produces a prolonged blast of 7½ seconds duration, followed by a silent period of like interval.

Coney Island light, on the westerly end of the island, is now visible, its red light flashing at intervals of 5 seconds It is visible about one-sixth further, or over 16 miles.

Soon the clanging of Fort Wadsworth bell-buoy is carried to the ear, and then we observe the flashing alternately red and white light of Fort Wadsworth light station. Here, in foggy weather, a bell is struck by machinery; one stroke, then

FIG. 6.—LAMP FOR A G A BUOY

a silent period of 15 seconds. On the easterly side of the Narrows is Fort Lafayette fog signal station, also equipped with a bell.

Off St. George, Staten Island, at the easterly entrance of Kill van Kull, is Robbins Reef light station, which is kept by a woman. It has a flashing white light visible 13 miles, and a compressed air fog siren.

As we swing into the depot again we see behind Robbins Reef, faint against the glaring lights of Manhattan, the torch of Liberty illuminating the world. On this imaginary trip we have only seen a few of the lights of New York harbor, but enough to realize how carefully Uncle Sam safeguards at night the gateway to the Metropolis of the New World.

Annual Report of the Secretary of the Navy

In his annual report for the fiscal year 1912, Honorable George von L. Meyer, Secretary of the Navy, urges strongly the passage of a bill creating a Council of National Defense made up of two Cabinet officers, four Senators, four Con-

FIG. 7.—HAULING AN ACETYLENE GAS BUOY ABOARD LIGHTHOUSE TENDER LARKSPUR

gressmen, two Army officers and two Navy officers. It is expected that such a council would tend toward and result in a better understanding and in a definite policy in the maintenance and upbuilding of the national defense.

As regards new construction, the Secretary points out that considering the number of dreadnoughts and battle cruisers as a measure of naval strength, if the Powers do not increase their present programmes, and if Congress authorizes only two

FIG. 8.—CLEANING AND ADJUSTING LAMP ON GOWANUS SHOALS BUOY

FIG. 9.—CHARGING PINTSCH BUOY WITH GAS

capital ships every year, the United States will have dropped from second to fourth place in strength. Furthermore, the supposition that the opening of the Panama Canal will double the strength of the fleet is erroneous, since it will not increase the number of ships available, but will only reduce the time necessary to transfer a vessel from one ocean to the other. To maintain and increase the strength of the United States as a naval power, a continuing annual building programme is urged as necessary. In the opinion of the Secretary, a total of forty-one battleships and a proportional number of other fighting and auxiliary vessels is the least that will place this country on a safe basis in its relation to the world powers. This number should be reached as soon as practicable, and then the fleet should be kept up to its standard strength by replacing obsolete vessels with new ones by a uniform yearly replacement programme. The General Board recommends that provision be made at the coming session of Congress for the addition of four battleships, two battle cruisers, sixteen destroyers, one destroyer tender, two transports, one ammunition ship, six submarines, one submarine tender, one supply ship, two gunboats, two seagoing tugs, one dry dock and one submarine testing dock. The battleships asked for will simply replace four battleships which will become obsolete after twenty years of service, and the numerical strength of the navy will not be changed. The policy of providing four destroyers for each battleship and one tender for each sixteen destroyers is urged as indispensable.

An Oil-Engined Coaster

BY GEORGE THOW

The first full powered oil-motor coasting cargo vessel was recently built in a shipbuilding yard at Ardrossan, on the Firth of Clyde. Although there are many motor cargo boats in Continental ownership, these have been designed with an eye to canal work as well. This Scotch vessel is for the usual coasting service, and will be employed in a trade that will take her to the largest ports and to compete with ordinary engined steamers. She is for a Glasgow owner, and will be run regularly on the round voyage between Glasgow, Liverpool, Cardiff and Dublin.

As a matter of fact the vessel was designed originally for reciprocating engines, and the intention to have oil engines installed was an afterthought. She is therefore somewhat fuller aft than she would be if firstly designed for motor propulsion, but advantage of this is taken to provide accommodation for the oil tanks.

In length the vessel is 147 feet, in breadth 25 feet, and in draft 10 feet. The builders are the Ardrossan Dry Dock & Shipbuilding Company, and the coaster will be classed 100 A-1 at Lloyd's. The motor selected is the four-cylinder Bolinder direct-reversible engine, using crude oil, having an indicated horsepower approximately of 500 and capable of giving a sea speed of fully 8½ knots. A Glasgow firm of engineers, Messrs. Douglas, Primrose & Company, have secured the engining contract. The Bolinder motor is a Swedish engine which has gained a good reputation on the Continent. A demonstration boat toured the British Isles, and the motor is being adopted by fishing craft. A large full-powered drifter was launched at Eyemouth a month or two ago, and is fitted with a 120 brake-horsepower Bolinder crude oil motor, and a 92-foot barge is, we understand, being built in this country to be engined with that make.

But before entering into details of the motor it may be stated that one of the reasons that induced the owner of the Ardrossan coaster to substitute an oil engine for steam was the increased gain in carrying capacity. As originally designed for steam the deadweight tonnage was calculated at 420 tons; the substituting an oil engine raises the deadweight capacity to 500 tons. There is also an important reduction in the wage bill of the engine-room staff, and the general costs of running are expected to be considerably under those of steam engines. Another advantage is that the machinery will not extend nearly so far forward as steam engines and boilers would do, and therefore practically the whole of the 'midship section of the ship will be available for cargo carrying. This is very serviceable in the coasting trade for quick loading and discharge, and is also advantageous for stowing awkward cargo in the shape of machinery, lengthy constructional ironwork, etc.

All the propelling machinery and oil tanks will be aft. When the vessel is light she can be trimmed by water tanks in the forepeak. In the construction of the oil tanks a departure is being made from the method adopted in some previous vessels built abroad. In these ships the frames were made exceptionally deep and the spaces covered over, thus forming tanks in the structure of the vessel itself; but in the Ardrossan boat special tanks will be made and fitted into the spaces between the frames, so that if necessary they can be removed at any time.

The propeller, which will be much smaller than that necessary for reciprocating engines and lower set, will be completely immersed in all stages of the vessel's trim. The revolutions will be over 200. To work the auxiliary plant a donkey boiler, fed with oil fuel from the same tanks that supply the main engine, is to give steam to the steam steering gear, steam capstans and steam cargo winches.

The Bolinder engine is made for marine work with either reversible propeller blades, for small craft, reversing gear, or direct reversible. The engine for the Ardrossan boat is of the direct reversible type. It is an engine of the modern two-cycle class, delivering a power impulse for each revolution of the flywheel. It has no valves, cams, gears or electric sparking device, and the construction is such that all the parts work automatically and cannot be thrown out of adjustment. On the up-stroke of the piston a partial vacuum is created in the enclosed crank case, causing the necessary charge of air to rush in at two opposite inlets. Near the end of the stroke an oil pump automatically injects the proper amount of oil through a nozzle into an ignitor ball. This ball has been previously heated to a dull red heat by a blow-lamp, so that the hot walls of this ball immediately convert the oil into vapor. The mixture of air and oil gas is then automatically fired, driving the piston downward, during which the charge of air previously drawn into the crank case is compressed, and when the piston approaches the end of the down-stroke it uncovers the exhaust port, permitting the burnt charge to escape through the silencer until its pressure reaches that of the atmosphere. Directly afterwards the transfer port on the opposite side of the cylinder is uncovered by the piston, thereby allowing the charge of air compressed in the crank chamber to rush into the cylinder, where it is deflected upwards by the shape of the top of the piston and caused to fill the cylinder, thereby expelling the remainder of the burnt charge. By means of two ports the ignitor ball is thoroughly cleaned of all deposit, as fresh air rushes through it, and thus powerful ignitions are ensured. All those operations described take place in the cylinder and crank case with every revolution

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CANADIAN PACIFIC LINES.—Two new vessels of 15,000 gross tons each are being built at the Fairfield Works for the Pacific service of the Canadian-Pacific Railway. These vessels are 590 feet long, 68 feet beam and 46 feet depth. They are propelled by turbine machinery, and are designed to accommodate 200 first class, 100 second class and 800 third class passengers, making them the largest vessels with one exception trading between the American continent and Japan and China.

Experiments on the Fulton and the Froude*

BY PROF. C. H. PEABODY†

The objects of the experiments related in this paper are the investigation of the characteristics of towboats and the determination of favorable conditions. The applicability of steamboats for towing was so evident that forms and proportions were settled early in the history of steam navigation, being controlled, in part, by the ideas then prevalent concerning the action of screw-propellers and in part by the conditions of service which required simplicity and reliability in the hands of men economically available for boats of that class. The conditions of the service favor conservatism, and consequently the early types have been generally preserved, though there are instances of progressive designs that have broken away from tradition, specially for large sea-going towboats. The propellers used for towboats have habitually been four-bladed, with large area and wide tips, and have had a large pitch ratio, commonly from 1.3 to 1.5. The pitch ratio is controlled by the use of relatively slow engines, and the form of blade according to the old ideas concerning the action of screw-propellers, especially as applied to towing. Many designers have been of the opinion that both width of blade and pitch ratio could advantageously be reduced, and when circumstances appeared favorable have made such changes.

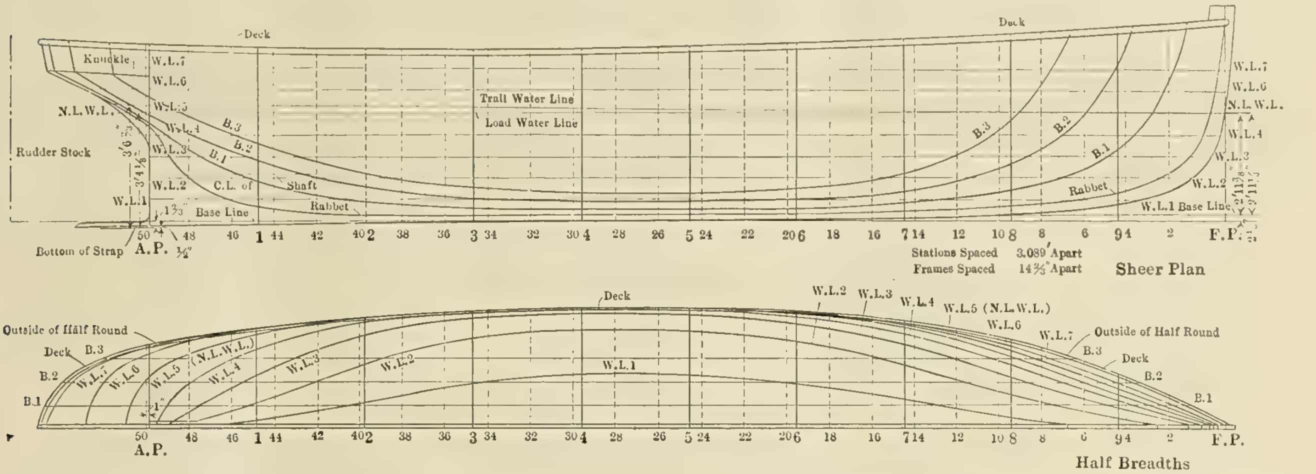


FIG. 1.—LINES OF THE FULTON. LENGTH (O. A.), 34 FEET 4 INCHES; LENGTH (N. L. W. L.) 31 FEET 9¼ INCHES; BEAM (N. L. W. L.), 7 FEET ⅛ INCH; DRAFT (MEAN TRIAL W. L.), 3 FEET 3 INCHES; DISPLACEMENT (M. T. W. L.), 22,160 POUNDS (S. W.); WETTED SURFACE (M. T. W. L.), 289 SQUARE FEET

During the experiments made in the summer of 1911 on the *Froude* with propellers having various pitch ratios and widths of blades, advantage was taken of the opportunities to make experiments in towing and pulling; these experiments could not be reduced in time for presentation with other results, which is not to be regretted, as they can be conveniently presented here in connection with experiments on the *Fulton*, which is a typical harbor towboat made to one-third the size of its prototype the *Sotoyomo*, for which data are given by Naval Constructor D. W. Taylor, U. S. N., in the fifteenth volume of our *Transactions*. Speed trials were made of the *Sotoyomo* in 1907 near Mare Island navy yard, the model was towed in the model basin, and results of these investigations have been kindly furnished to me by the chief constructor, Admiral R. M. Watt, U. S. N.

* A paper read before the Society of Naval Architects and Marine Engineers, New York, November, 1912.

† Professor of Naval Architecture and Marine Engineering, Massachusetts Institute of Technology, Boston, Mass.

The principal dimensions of the *Sotoyomo*, the *Manning* and the *Sonoma* (a new ocean towboat for the navy) are given for convenience in the following table. The *Manning* is given because it is the prototype of the *Froude*, and the *Sonoma* for comparison with the *Manning*, which has characteristics not unlike an ocean towboat. Thus we have in the

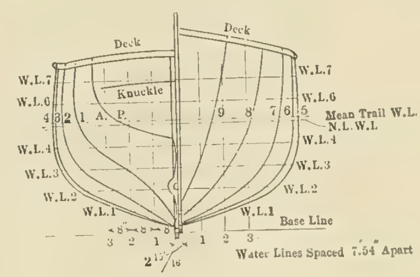


FIG. 2.—BODY PLAN

Fulton and the *Froude* little towboats of the two principal types.

	Length L. W. L.	Beam.	Mean Draft.	Displacement.	Speed, Knots.
Sotoyomo..........	92.7	21.	9.16	258*	10.5
Manning...........	188	32	12.3	1,000*	16
Sonoma............	175	34	14.5	1,100*	14
Fulton............	30.9	7	3.25	9.6†	6.4
Froude............	37.6	6.4	2.52	8†	7.2

* Salt water. † Fresh water.

The lines of the *Manning* and the *Froude* can be found in the author's paper of last year and need not be repeated here. The characteristics of the experimental propellers are given here for convenient reference.

PROPELLERS FOR THE FROUDE, 1911

	Pitch Ratio.	Projected Area-ratio.
No. 1..............................	0.8	0.61
No. 1A.............................	0.8	0.50
No. 1B.............................	0.8	0.44
No. 2..............................	1.1	0.59
No. 2A.............................	1.1	0.52
No. 2B.............................	1.1	0.45
No. 3..............................	1.5	0.60
No. 3A.............................	1.5	0.53
No. 3B.............................	1.5	0.44

These propellers all had oval blades with sharp edges and were correctly planed.

The lines of the *Fulton* are given in Fig. 1; they are substantially the same as those of the *Sotoyomo*. The three experimental propellers had the following charactertistics:

PROPELLERS FOR THE FULTON, 1912.

	Pitch Ratio.	Projected Area-ratio.
No. 1	0.8	0.56
No. 2	1.0	0.53
No. 3	1.29	....

The propeller No. 3 was a close copy to one-third the size of the propeller of the *Sotoyomo*, which is represented by Fig. 3, made from a drawing kindly furnished by Admiral H. I. Cone, U. S. N., with the exception that the propellers of the *Fulton* had no rake. All the propellers were cast and had the surfaces smoothed but not planed; as is customary for such propellers there was some thickness near the edge which was rounded on the back to the edge. The propellers, which were made by the Hyde Windlass Company, of Bath, Me., were closely correct to pitch; the pitch ratios are so nearly correct that variations can have little, if any, effect on our results.

The hull of the *Fulton* was built in the shops of the Massachusetts Institute of Technology; it had double-sawed oak frames spaced 15 inches apart, oak keel, keelson, stem, sternpost and beams, and was single-planked white ⅞-inch white cedar. The construction and general arrangement are shown by Fig. 4. Measurement after construction showed that the form was fair and true to the lines. In order to reduce wind resistance the boat was practically flush-decked, the 'midships being covered with light hatches that could be opened for convenience in installing and running the machinery. The boat was maneuvered from a cock-pit forward and was very handy under our system of indirect electric propulsion.

The machinery and apparatus used on the *Froude* in 1911 were transferred to the Fulton, and do not require description beyond that given in the former paper.

The tow-rope pull in both years was taken by the vertical arm of a bent lever; the horizontal arm of the lever pulled directly on a good spring balance, a dash pot being used to reduce vibration. This device was found to be convenient and as delicate as conditions warranted. The points for a series of tests came on a fair curve, and appeared to have an error of not more than 1 percent.

During the experiments of 1911 the *Froude* towed a drag made of three railroad ties bolted together in a triangle and towed from the apex. During the experiments of 1912 the *Fulton* towed the *Froude*, which had a plank bolted across the stern to augment its resistance. The drag used in 1911 was effective, towed steadily and was not affected by wind action; it was very inconvenient, especially during turns. The *Froude* was considered to tow more like a barge, and with a steersman aboard was more convenient; it was affected by wind resistance.

Considering the long time required for a towing test over a measured course, especially for the turns, and the desirability of being able to choose sheltered parts of the basin, we decided to try measuring speed by a propeller log set forward of the boat. The propeller was 8 inches in diameter, had a pitch of 14 inches, and three blades. It was carried by a vertical rod supported by an outrigger above water, had its axis 9 inches below the surface, and was set 8 feet forward from the stem of the boat. Trials of this log with the *Fulton* running free over the measured course indicated that this log would give satisfactory results; in use, especially when there was some wind, it appears to have been influenced by surface drift, and in consequence the determination of speed on the towing tests is affected by errors that may be 2 or 2½ percent. This is indicated by the dispersion of points for a curve and by check runs over the measured course. This use of the log during towing was the only divergence from tests of the two preceding years.

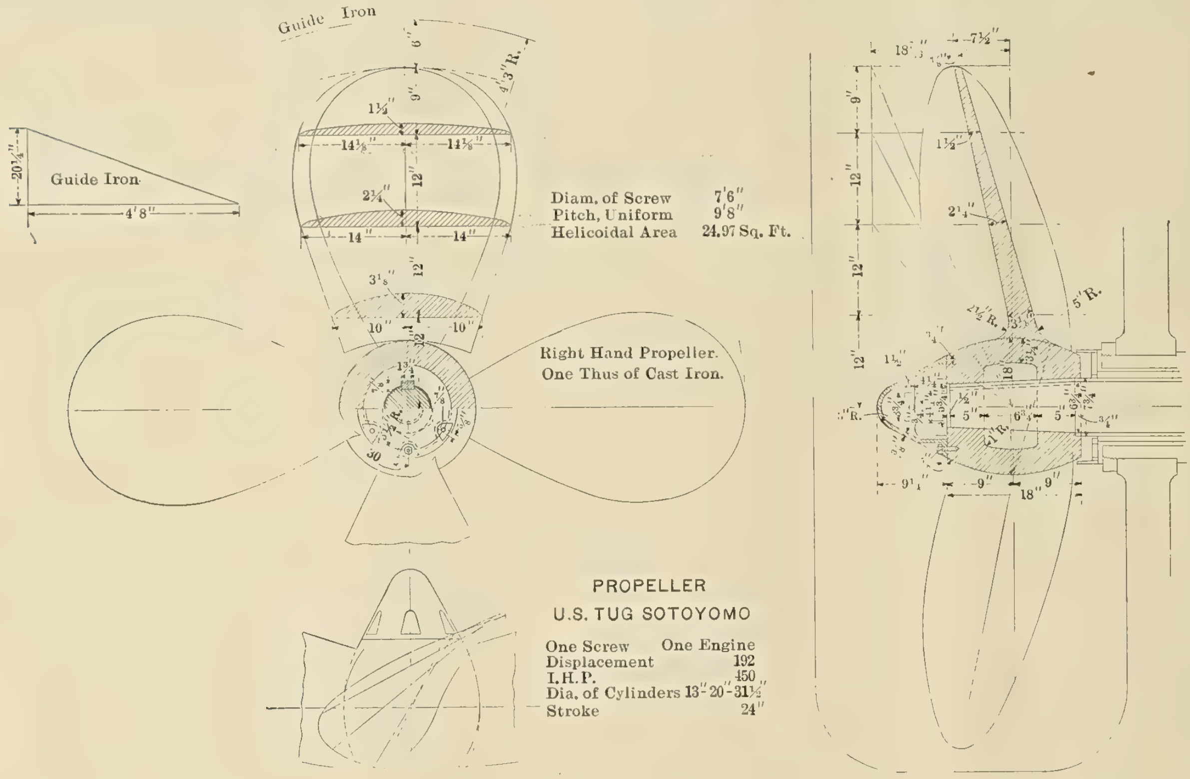


Fig. 3

Influence of Blade Area

A towboat, especially of the harbor type, has three various kinds of duty, namely: (1) To run free, passing from place to place, and perhaps seeking business in face of competition; (2) towing at a reduced speed, commonly at half speed or somewhat more, and (3) pulling or pushing a ship into her berth at very slow speed, or nearly without speed.

Running-free towboats differ from other classes only in that, being high-powered to enable them to tow, they have relatively high speed even though not designed with that in view.

To have a ready standard of comparison in our discussion of the effect of width of blade and area ratio, let us consider that the standard Admiralty blade proposed by Froude has been found sufficient for all classes of ships (excepting towboats), until cavitation has brought about the use of wide blades in certain cases. Now this standard blade has a maximum developed width of 0.2 of the diameter of the propeller, which gives a developed area ratio for four blades of 0.36; the projected area ratio is somewhat less, depending on the pitch. The experiments on model propellers by Naval Constructor Taylor show that such an area ratio is preferable for the generality of propellers, but that the ratio may be increased up to 0.48 without appreciable disadvantage. From a study of Mr. Taylor's experiments and of the tests about to be related, I am ready to advise the use of a projected area ratio of about 0.5 for four-bladed propellers for all towboats. The minimum area ratio of the propellers used on the *Froude* in 1911 is 0.44.

In considering the effect of width of blade and projected area ratio let us take up the results of experiments on the *Froude* with the several propellers given in the table for each of the three several duties of a tow-boat, namely, running free, towing and pulling (or pushing).

For running free we may refer to the author's paper submitted last year, which gives the results of tests with the propellers given in this paper. A reference to this paper will show that the curves of power on speed for a given pitch ratio and for all projected area ratios from 0.44 to 0.60 are practically identical; the several curves for the various areas can be distinguished, but the separation is no more than must be attributed to the unavoidable error of experiment. This result is unexpected, because the increase of area ratio for the experimental propellers of Mr. Taylor is accompanied by a loss of efficiency amounting to 3 or 4 percent out of 60 to 66 percent.

The effect of area on towing is shown by Fig. 5, which gives all the points representing the separate runs and also mean curves, with brake-horsepower plotted on speed. Points for tests with the original width of blade are represented by triangles, the intermediate widths have crosses, and the least widths have circles. For the pitch ratios 0.8 and 1.1 all points lie on or closely adjacent to the curves; for the pitch ratio 1.5 the points show a little dispersion. It would be possible to draw three separate curves for this pitch ratio of 1.5, and in that case the curve for the least area ratio (0.44) would lie the lowest and indicate a slight advantage for the narrower blade. In reading these diagrams, which for convenience are put on one plate, it will be noted that there are three base lines selected so as to separate the curves for the several pitch ratios.

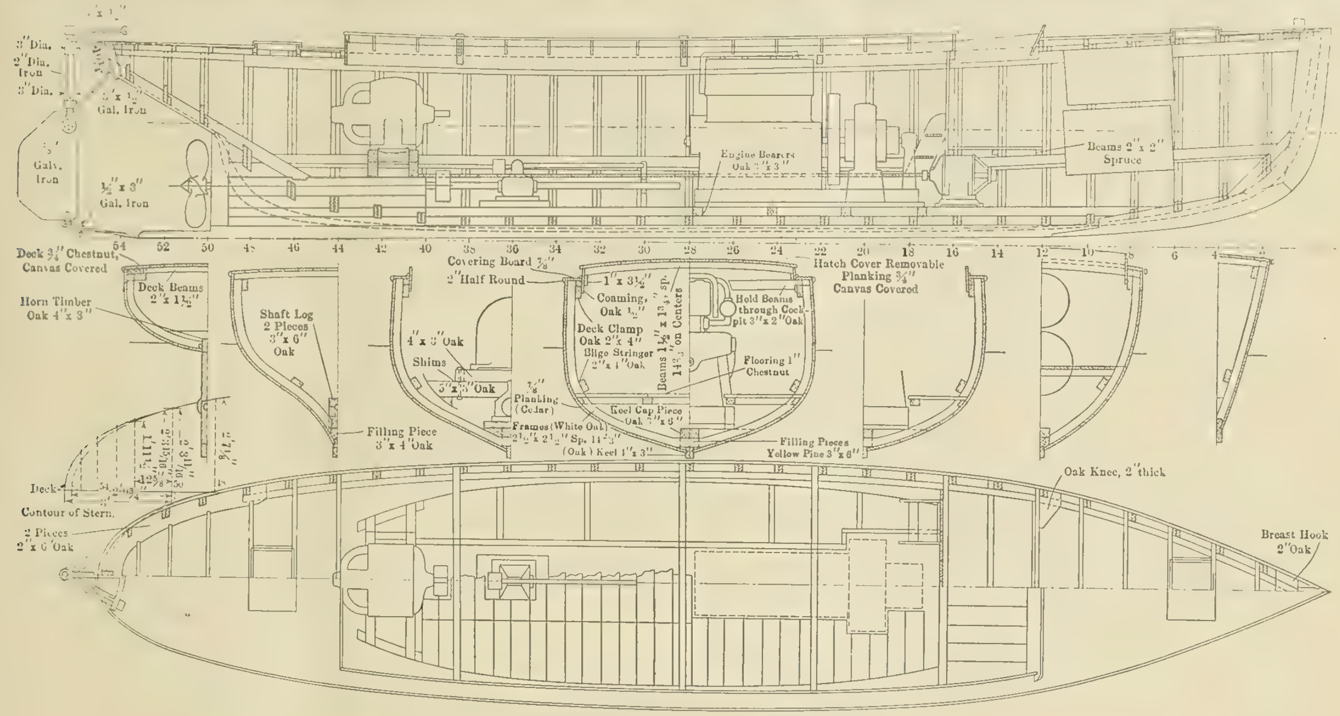


FIG. 4.—CONSTRUCTION PLANS OF THE FULTON

On Fig. 6 the results of our measurements of thrust of the propeller-shaft are plotted in the same manner as the power. These results are quoted because they represent a direct measurement in which we have great confidence, and as the points and curves have the same characteristics as those for power on Fig. 5 they give direct evidence of the reliability of our power curves.

For our pulling experiments the *Froude* was secured by a line from our weighing beam to a pile of the draw of the Harvard Bridge. The motor was allowed to run at various powers and the tow-line pull was read directly on the spring balance, allowing, of course, for the inequality of the arms. The results are shown by Fig. 7 for the original area ratio of about 0.6 only; similar experiments with narrower blades were not made, partly because of lack of time and partly because their importance was not realized. The experiments gave no indication of breaking of the propeller race except at high powers for the largest pitch ratio.

From these experiments the conclusion to my mind is direct and positive, namely, that the width of blade and the projected area ratio of a propeller have little or no influence on the performance of a towboat when (1) running free, or (2) towing. The evidence with regard to pulling is incomplete, but I believe that with a pitch ratio not greater than 1.3, a moderate area ratio will avoid breaking the race. It is to be borne in mind that our least area ratio is 0.44, which is nearly a fourth greater than the developed area ratio that has been found sufficient for general service.

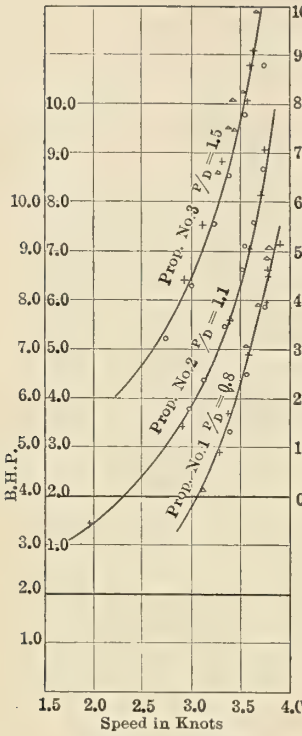


FIG. 5.—TOW RUNS OF FROUDE

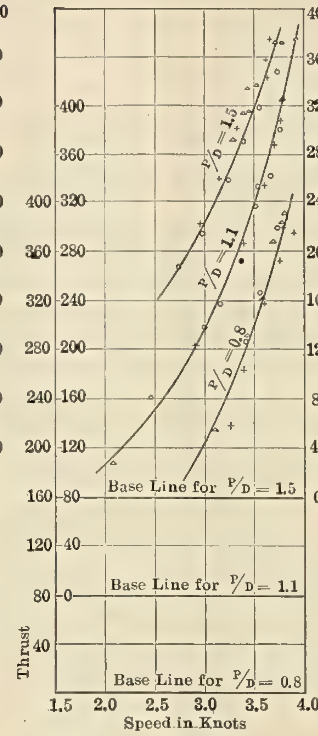


FIG. 6.—TOW RUNS OF FROUDE

This conclusion, if accepted, has a wide importance, because it indicates that the best propellers for towboats have a well-rounded or oval blade and a moderate width. There appears, therefore, to be no reason for retaining the traditional towboat propeller with its excessive area and wide-tipped blades, more especially as *Froude's* recent experiments show that such wide-tipped propellers are about 3 percent less efficient than well-rounded blades.

This separate, preliminary investigation of the effect of

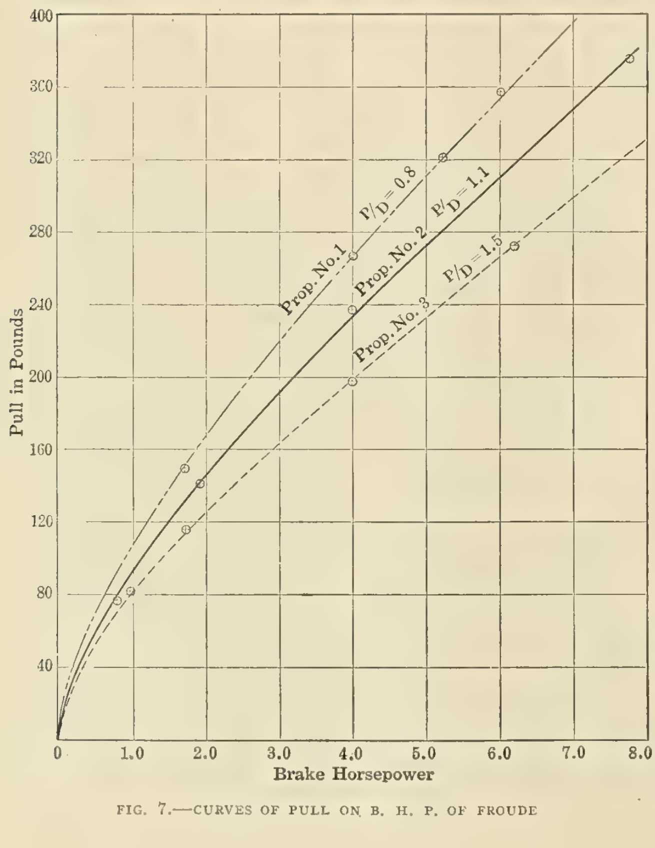


FIG. 7.—CURVES OF PULL ON B. H. P. OF FROUDE

blade area (or rather of its ineffectiveness) clears the field and allows us from now on to concentration on other elements which have determining effects.

EXPERIMENTS ON THE FULTON, 1912

Three types of experiments were made this year on the *Fulton:* (1) running free; (2) towing at various speeds up to about 0.6 full speed, and (3) pulling, both going ahead and backing. Three propellers were used, all of which had very nearly the same projected contours as the *Sotoyomo* propeller as shown in Fig. 3; the smaller pitch-ratio propellers had somewhat less width fore and aft and less helicoidal area, but since the experiments on the *Froude* showed that area has little or no effect on performance, the variations of helicoidal area of these three propellers need not call for attention.

In order to present the quality of our work and the regularity of results obtained, an individual diagram for each type is given in Figs. 8, 9 and 10, with all the points representing separate experiments as well as with fair curves. Thus Fig. 10

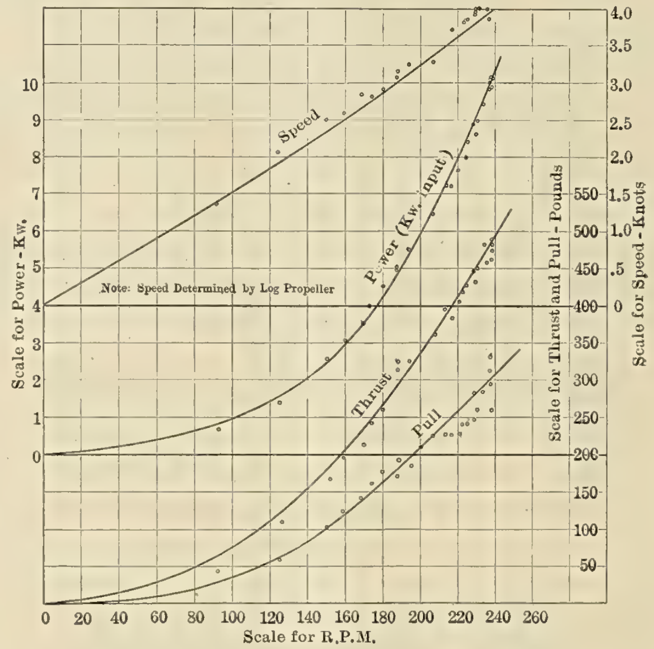


FIG. 8.—TOWING TRIAL OF FULTON. PROPELLER NO. 3, PROPELLER SETTING NORMAL, PITCH RATIO 1.289, LENGTH OF TOW-LINE 80 FEET

shows curves of speed propeller thrust and brake-horsepower, all plotted on revolutions of the propeller. For both speed and thrust there are curves with and against the wind; the power for a given setting of the machinery is not appreciably affected by the wind under the favorable conditions selected for experiment, and only one curve is drawn. On this plate the power is the input to the motor in kilowatts which is afterwards corrected by comparison with our brake tests to given brake-horsepower as used in the other plates. It may be claimed that the regularity and distribution of points for these experiments leave little to be desired, and a comparison with standardization of full-sized ships in a tideway under such weather conditions as may chance to be experienced will lead us to wonder that such tests are as good as they are, rather than that they are not more nearly what we would desire.

Fig. 8 gives for one of our series of towing experiments individual points and curves showing speed, power, propeller thrust and tow-line pull, all plotted on revolutions of the propeller. The curves of thrust and power call for little comment unless we notice that the greater apparent dispersion of points is partly due to the fact that wind had relatively larger effort on account of slower speed.

As was explained in the preliminary statement the speeds

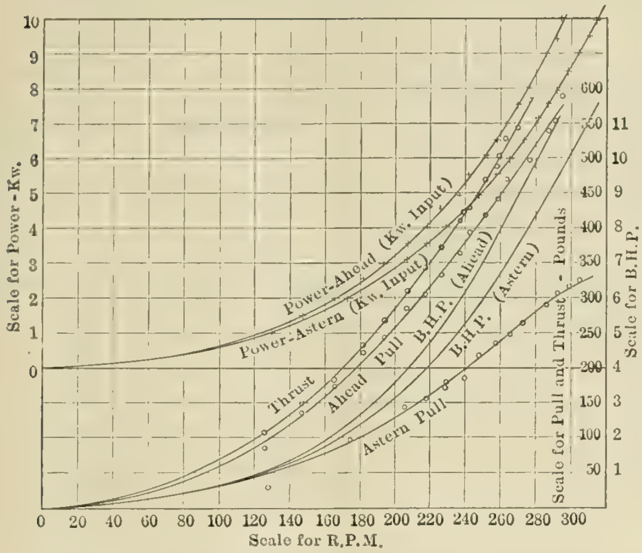


FIG. 9.—PULLING TRIALS OF FULTON, PROPELLER NO. 1, PROPELLER SETTING NORMAL, PITCH RATIO 0.8

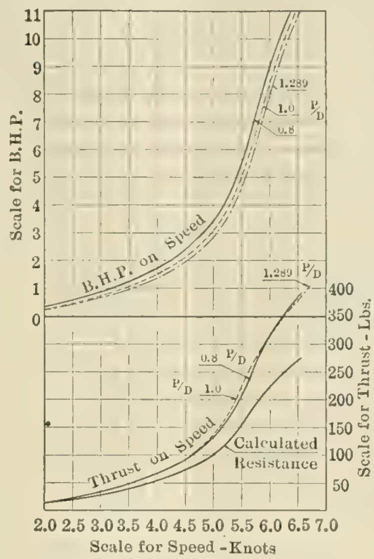


FIG. 11.—RUNNING TRIALS OF FULTON

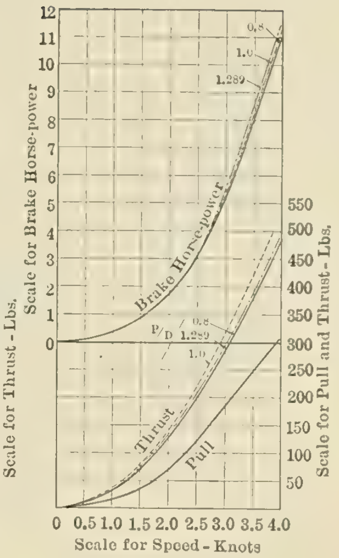


FIG. 12.—TOWING TRIALS OF FULTON

during towing were measured by a little propeller 8 inches in diameter and with 14 inches pitch, which was carried by a bow outrigger so that its axis was 9 inches below the water level and 8 feet in front of the stem of the boat. Though this propeller log showed good results on special runs without a tow over the measured course, its operation during towing was less satisfactory, chiefly because as the season advanced we found it necessary to accept weather conditions less favorable than we would like, trying to minimize wind influence by choosing sheltered parts of the basin. Several runs were made in succession with the wind, followed by others against the wind. In drawing the fair curves greater weight was given to points which our records indicated as more reliable, and especially to points favored by shelter or other weather conditions. If two points which are apparently rather wide from the speed curve, and which we believe to be erratic, are neglected, the dispersion of points indicates that the probable error of speed measurement of a single test may be as large as 4 percent, but we believe that the mean curve is much nearer the truth, and we desire to claim a precision of 2 percent, which, after all, is not unfavorable considering that towing is at low speed. The dispersion of the points showing thrust and pull on tow-line is a direct consequence of the uncertainty of speed.

Fig. 9 shows points and curves of pulling tests with the tow-line secured to a pile of Harvard Bridge. Going ahead the weigh-beam was set up astern, but in backing it was set up near the bow. All these runs were made readily, and in particular there was no indication that the race from the propeller had any tendency to break. Our thrust mechanism did not allow of measurements while backing. It must be admitted that the points and curves leave little to be desired, and that the records can be accepted without reservation.

Certain subsidiary experiments will be reserved for future discussion to avoid confusion.

RUNNING FREE

The performance of towboats of the ocean-going and harbor type may be discerned from Fig. 9.

As was pointed out in last year's paper the propeller with maximum pitch ratio (1.5) as used for towing on the *Froude* had a small clearance from the fair water on the stern post, and consequently it demanded a disproportionate power. This does not affect our discussion of the effect of area ratio, but

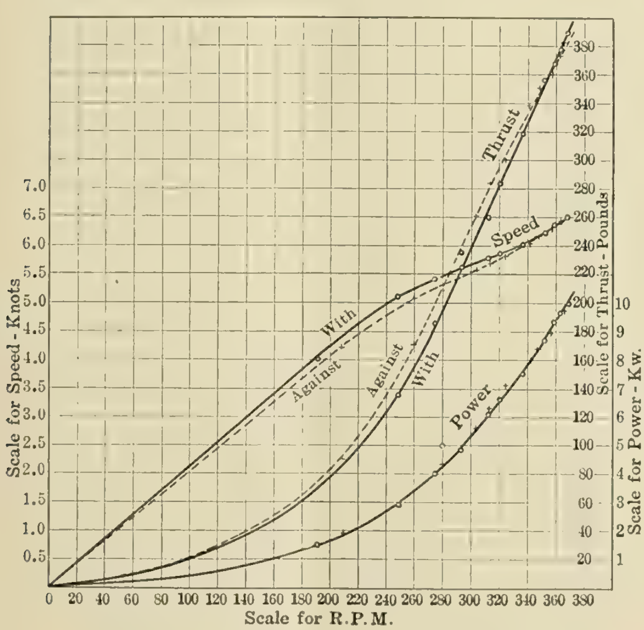


FIG. 10.—STANDARDIZATION TRIAL OF FULTON, PROPELLER NO. 1, PROPELLER SETTING NORMAL, PITCH RATIO 0.8

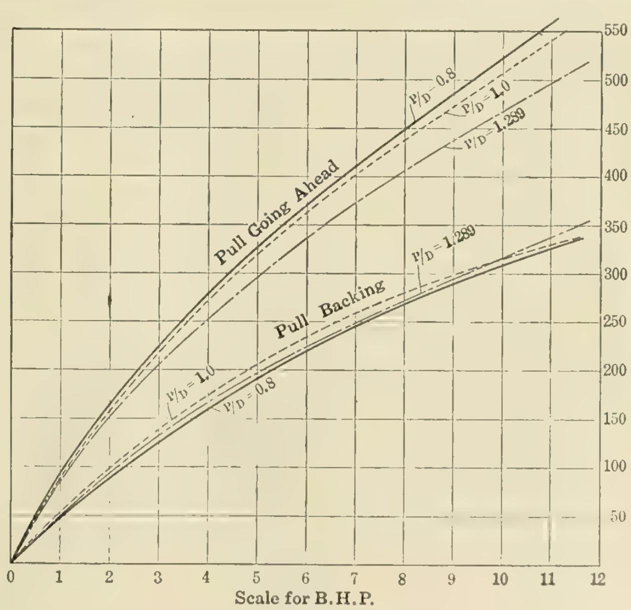


FIG. 13.—PULLING TRIALS OF FULTON

throws it out of line in the discussion of the effect of pitch ratio. Comparing, now, the other two propellers having pitch ratios of 1.1 and 0.8, it appears that at 7 knots speed they required, respectively, 8.3 and 8.5 brake-horsepower; this result may be attributed directly to the poorer efficiency of the low-pitch wheel, with only the reservation that experiments on propellers would lead us to expect a somewhat larger disadvantage.

The running trials on the *Fulton*, shown in Fig. 11, indicate quite clearly the disadvantage of a small pitch ratio which is associated with a poorer propeller efficiency; thus the propellers with pitch ratios of 1.3, 1.0 and 0.8 at 6.5 knots require 10.7, 10.9 and 11.5 brake-horsepower, respectively, or, inverting the comparison, those which with 11 horsepower would give the *Fulton* speeds of 6.55, 6.51 or 6.37 knots. The difference, though not large, might be important in getting a tow away from a competitor.

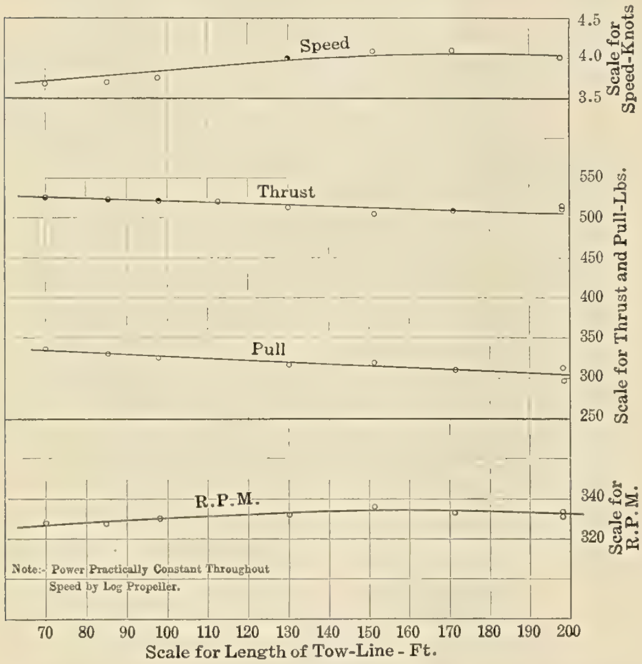


FIG. 14.—TOWING TRIAL OF FULTON. PROPELLER NO. 1, PROPELLER SETTING NORMAL, PITCH RATIO 0.8

In the same figure there are shown curves of propeller thrust for the two propellers with lower pitches; for the pitch ratio of 1.3 only the upper end of the curve appears, as the lower part was not properly recorded by our thrust mechanism. These curves are quoted and also the resistance (as determined by the theory of mechanical similitude) from the towing of the *Sotoyomo's* model at Washington.

Towing

The performances of ocean-going and harbor towboats towing at full power and at about 0.6 full speed are shown in Figs. 5 and 12. Fig. 12, which represents results of experiments on the *Fulton*, shows a small advantage for the low-pitch propeller. Fig. 5 shows a corresponding advantage for a propeller of the *Froude* with a pitch ratio of 0.8 as compared with one having the pitch ratio 1.1; the coarse pitch-wheel with a ratio of 1.5 appears to be at a great disadvantage, but I mistrust that this is to be attributed in part to a defective clearance from the stern post, as already indicated; such a pitch ratio is not fitted for an ocean-going tug, and the importance of the comparison is therefore diminished in consequence.

Fig. 12 shows also the propeller thrust and the pull on the tow-rope measured by our weigh beam, which are given as a matter of interest. The curious inversion of order of the thrust curves is yet to be explained.

It is to be noted that runs at less than about 0.6 full speed are with reduced power; they are most interesting experimentally, especially as the sequence of the points allows us to locate the curves certainly. A very important series which we have not attempted to run is to vary the speed at full power by increasing the resistance of the tow. Such a series of experiments, with the time required for adjusting resistance to speed, might profitably occupy a summer's work.

Pulling

The collected results of experiments on pulling against a fixed point with 100 percent slip of the propeller are shown by Fig. 7 for the *Froude* and by Fig. 13 for the *Fulton;* the latter was tried pulling both ahead and astern.

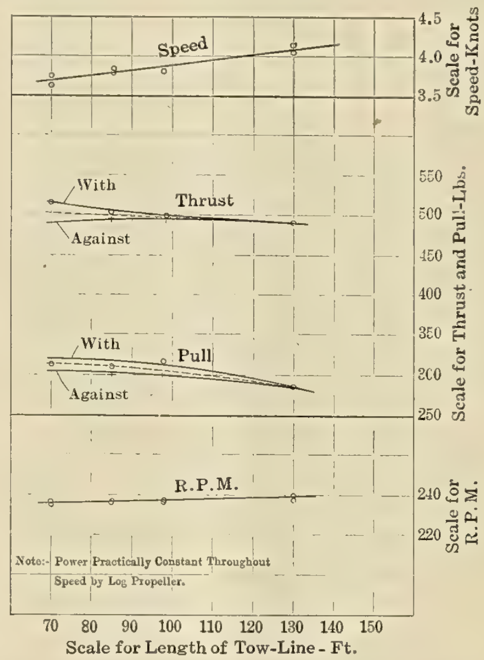


FIG. 15.—TOWING TRIAL OF FULTON. PROPELLER NO. 3, PROPELLER SETTING NORMAL, PITCH RATIO 1.289

On both the *Froude* and the *Fulton* propellers with smaller pitches gave better results pulling ahead. On the *Froude* the advantage of the small-pitch propeller was very striking; thus at 7 brake-horsepower the pulls for the propellers having pitch ratios of 0.8, 1.1 and 1.5 were 400, 350 and 300 pounds. On the *Fulton* the smaller pitch showed an advantage but by no means so notable; thus at 11 brake-horsepower the propellers having the pitch ratios 0.8, 1.0 and 1.3 gave the pulls 560, 545 and 490.

Length of Tow-Line

For all the experiments thus far recorded the length of the tow-line was constant, being 80 feet when the *Froude* was towing and 70 feet for the *Fulton*. In Figs. 14 and 15 results of experiments on the *Fulton* with varying lengths of tow-line are shown. It will be noted that these propellers having pitch ratios of 0.8 and 1.3 gave substantially the same results, as indeed might be expected, since the question under consideration is the effect of the race of the propeller on the resistance of the tow.

The most interesting feature of these results is the effect of length of line on speed; the changes being small are to some extent covered up by the lack of accuracy of our bow-log for measuring speed; nevertheless, there appears to be a substantial advantage from use of a long line which is best brought out in Fig. 14. Bearing in mind that the *Fulton* is 30 feet long there is a gain of about 10 percent in speed due to lengthening the line from twice the length of the towboat to six and a half times the length. In this comparison the pull on the tow-line gives the most positive indication of the advantage of a long line; this confirms the result just quoted in terms of speed, as the pull diminishes about 10 percent.

Towing Abreast

In a seaway ships and barges are always towed with considerable length of line for obvious reasons; in smooth, restricted waters the towboat is commonly brought alongside. In Fig. 16 curves are shown with the *Fulton* towing with an 80-foot line (less than three times its length), and towing abreast. There is an advantage of 10 to 12 percent when towing abreast, which is about the advantage of using a long

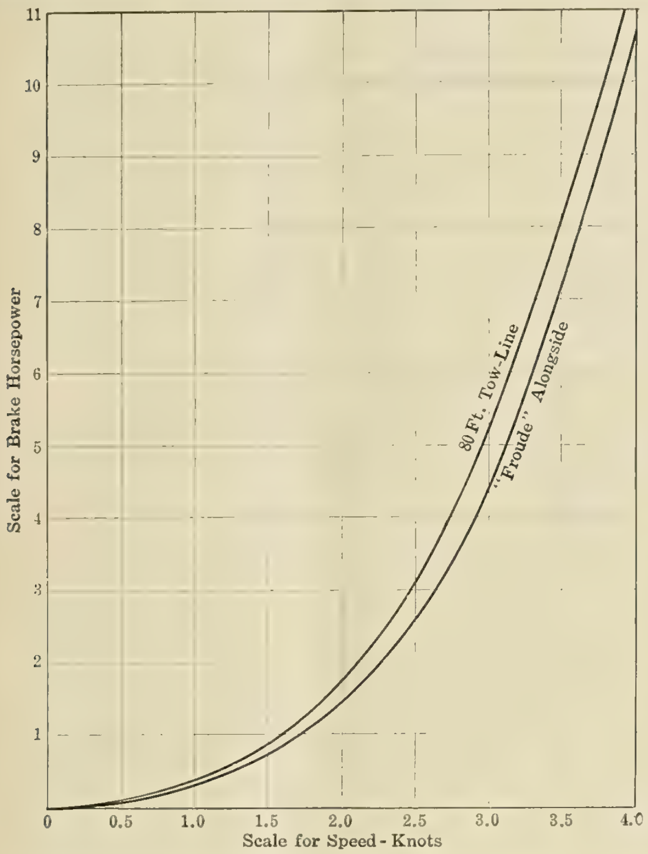


FIG. 16.—TOWING TRIALS OF FULTON. PROPELLER NO. 3, PROPELLER SETTING NORMAL, PITCH RATIO 1.289

tow-line (six or seven lengths). The common practice of either using a long line or towing abreast appears to be well founded.

Designing

The most practical use that can be made of the results of these tests on towing is for the design of new boats. Fortunately both the *Manning* and the *Sotoyomo* are well designed, having good form and fair lines. Perhaps the *Manning* is a little too fine for an ocean towboat, which is likely to be rather shorter and more beamy; the form of the *Sotoyomo* appears to be exceptionally good for speed, and might well be taken as a type for design except where speed is of minor importance, in which case a fuller body might enable a boat to carry more power.

It may therefore be suggested that designs for towboats shall be based directly on the tests of the *Froude* and the *Fulton* by the theory of mechanical similitude, bearing in mind that the experiments were all made in fresh water. The usual method of assuming resistance and power to be proportional to the density can be used in applying our results to boats operating on salt water.

Our results are given in brake-horsepower, while engines are habitually designed for indicated power. My own opinion is that a mechanical efficiency of 0.90 may be obtained for a well-built engine when in good condition; 0.85 may be shown by those who wish to be conservative.

The curves shown herewith show that towboats are likely to be driven well up to the critical speed at which the power increases more rapidly than the cube of the speed; consequently the common method of using an Admiralty coefficient for estimating power is, in my opinion, entirely inapplicable.

The speed for towing (about 0.6 full speed) is well under the critical speeds, and our experiments show that power varies nearly as the cube of the speed, and consequently the method of the Admiralty coefficient may properly be used.

It is therefore proposed that tow-boats shall be powered for towing at a speed-length ratio of 0.6 to 0.7 by the equation

$$I.\ H.\ P. = \frac{D^{2/3}\, V^3}{K\, L},$$

where D is the displacement in tons (2,240 pounds), V is the speed in knots, and L is the length on waterline in feet, while K is the Admiralty coefficient. The speed-length ratio is computed by the form

$$\frac{V}{\sqrt{L}}.$$

The speed-length ratio of the *Froude* when towing at 3¾ knots was 0.6, and the Admiralty coefficient corresponding is 21. The *Fulton* when towing at 3¾ knots had a speed-length ratio of 6.7, and for it the Admiralty coefficient is 22.5.

Having determined the power for towing at a given speed, the speed running free may be investigated, or we may simply accept what we get; especially at or near the critical speed it takes a large increase in power to affect the speed appreciably.

To complete the design requires the determination of the proper size and proportions of the propeller. Through the courtesy of the chief constructor, Admiral R. M. Watt, U. S. N., tests of models of our propellers for the *Fulton* have been made with large slips required for towing by Naval Constructor Taylor. From these tests and from our own data on thrust I hope to be able to present an analysis of this matter at some future time.

Launch of the Washington Irving

The New York Shipbuilding Company, Camden, N. J., launched, Dec. 7, the Hudson River steamboat *Washington Irving*, built for the Hudson River Day Steamboat Company, New York, and to be used in the New York City and Albany service. The vessel has a length over all of 416 feet 6 inches; a beam over all of 86 feet 6 inches; beam, molded, 47 feet; depth, 14 feet 16 inches; draft, 7 feet 4 inches. She is propelled by side paddle-wheels 24 feet 6 inches in diameter, each wheel having nine steel buckets, 15 feet long by 4 feet 3 inches wide, driven by a three-cylinder, compound, inclined, direct-acting engine, developing 6,000 horsepower. Steam is supplied by four single-ended and two double-ended Scotch boilers, carrying a working pressure of 170 pounds per square inch, working under Howden's forced draft system. The machinery was contracted for by W. & A. Fletcher Company, of Hoboken, N. J. The vessel was designed by J. W. Millard & Bro. and Frank E. Kirby, of New York. The former firm is well known as the designer of the municipal ferryboats and other harbor craft in New York, and the latter as the designer of the largest passenger steamers on the Great Lakes. These naval architects also collaborated in the design of the *Hendrick Hudson* and the *Robert Fulton*, of the Hudson River Day Line. The *Washington Irving* is destined for exclusive day passenger service, and has an available deck area for passenger use of 66,564 square feet, which will provide for 1,400 more passengers than the 6,000 called for in the vessel's certificate.

Recent Developments in Oil Fuel Burning*

BY E. H. PEABODY

With the continued increase in oil production the use of this ideal fuel is rapidly extending, particularly for marine purposes, and it seems worth while therefore to point out some of the main characteristics of the mechanical atomizer and modern methods of handling it. In attempting this the writer will of necessity have to look at the subject from his own point of view, and in the light of his own experience and the experiments carried out by the Babcock & Wilcox Company.

Atomization vs. Gasification

To begin with, Commodore Isherwood's conclusions of some forty years ago hold good to-day, namely, that atomization of the oil, as distinguished from vaporization or gasification in the burner, "is the only method that has been attended with success." There are not wanting those who still claim advantage for those forms of apparatus which, by various methods of treatment of the oil, admit the fuel to the furnace in the form of vapor. These systems, while successful in metallurgical work, have no standing in boiler practice, for the reason that they show no gain in efficiency, but, on the contrary, result in very poor capacity, the latter feature alone making them undesirable for marine use. At the same time some of these devices are ingenious and interesting, and I have taken as an illustration of the vaporizing type of burner an apparatus patented in England in 1907 by Mr. L. Dürr (Fig. 1). There are two burners in the form of retorts, a big one and a little one, the idea being that the little burner by playing a flame on the outside of the big burner will gasify the oil for the big burner and for itself as well. Several patents followed this one, each correcting some shortcoming of the preceding.

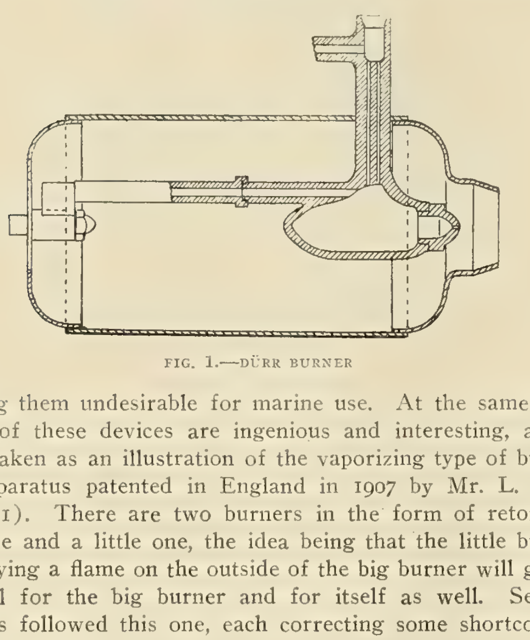


FIG. 1.—DÜRR BURNER

The well-known Köerting process patent, taken out in this country in 1905, contains a claim which covers heating the liquid oil unmixed with air or other gases to a point above its normal boiling point, maintaining the oil in a liquid state by pressure and delivering the superheated oil into a combustion chamber supplied with air, whereby the rapid disintegration and vaporization of oil in the presence of air are secured.

The idea here, as is more fully pointed out in the patent specifications, is that the heat stored in the oil at high-pressure will cause the liquid to flash into vapor when released at low-pressure, exactly as water, heated above 212 degrees F. under pressure, would flash into steam if released to the atmosphere. This is an exceedingly ingenious way of converting at least part of the oil into vapor without atomizing it, but as a matter of fact no gain results from this partial gasifying of the oil. This question has been tested out experimentally, and, what is more to the point, nobody is doing it, not even the users of the Köerting apparatus itself. The dangerous expedient, therefore, of heating oil above its flash point at atmospheric pressure is not found necessary.

* A paper read before the Society of Naval Architects and Marine Engineers, New York, November, 1912.

Effect of Heating Oil on Viscosity

The real value of heating the oil is rather a mechanical one, namely, to reduce the viscosity of the liquid so that it can be forced through the small passages of the burner and given a rapid whirling effect, sufficient in the more limpid condition of the oil to reduce it to a fine spray through the action of centrifugal force when liberated from the tip.

It will be found from a study of fuel oils that, while the viscosity is tremendously affected by changes in temperature at the lower ranges, very little difference in viscosity results with heating or cooling as the temperatures approach the flash point.

With all ordinary oils it may be considered that heating within 50 degrees F. of the flash point will be sufficient to render the oil suitable for use with the mechanical burner, and in the case of many of the lighter oils even this heating is unnecessary, the oil being sufficiently limpid at ordinary atmospheric temperatures.

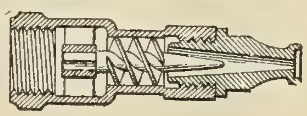


FIG. 2.—SCHÜTTE SPRAYER

Mechanical Spraying

Several methods of spraying oil by mechanical means have been suggested, such as forcing the liquid through a very fine aperture, forcing a jet of oil at high velocity against some object or against another oil jet, throwing the oil off from a rapidly revolving table or disk, or giving the liquid itself a whirling motion and reducing it to spray by centrifugal force.

In 1902 the writer tried the first idea and succeeded in making a very poor flat-flame mechanical atomizer by forcing the oil between two flat surfaces pressed closely together, and in 1907, when in answer to the navy's call we took up the matter of mechanical atomizing seriously, we tried some of the other schemes. The experiment of making two round jets of oil strike each other on the principle of the acetylene burner, resulted very interestingly in a flat spray—not fine enough, however, with heavy oils to be practicable. A mechanical atomizer, or, as it was called, a "self-atomizer," consisting of eight small jets meeting at a central point, was patented in England in 1904 by Mr. Charles Ferdinand de Kierskowski Steuart. It is a good example of spraying by forcing jets of oil to strike each other, but otherwise has attained no importance in the art.

The only method of atomizing fuel oil mechanically which has attained any practical success is that wherein the oil is given a whirling motion inside the burner tip. There are two distinct means for doing this—first, by forcing the oil through a passage of helical form, like a screw thread, and, second, by delivering the oil tangentially to a circular chamber from which there is a central outlet.

As an illustration of the first form I have selected the "spraying nozzle" patented in the United States in 1895 by Mr. L. Schütte. This is shown in Fig. 2. Judging by the patent, the inventor had principally in mind, with regard to this particular apparatus, the spraying of water, but the device is an excellent example of the use of the helical passage for giving the liquid a whirling motion.

Another adaptation of the same idea is shown in a patent taken out in England in 1899 by Mr. James Howden (Fig. 3).

He refers to heating the oil by means of live or exhaust steam or the waste gases, pumping it into an accumulator or air receiver for neutralizing the pulsations of the pump, and

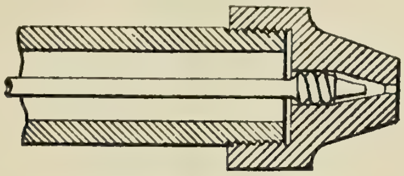


FIG. 3.—NOZZLE OF HOWDEN BURNER

then projecting the oil into the furnace in the form of fine jets or spray by passing it through a nozzle which he describes as having helical grooves on a part of the spindle within the nozzle, so as to impart a whirling motion to the oil. Howden's burner is adjustable in that the taper spindle moves "up and down" in the taper passage leading to the nozzle orifice. This movement of the spindle increases or decreases the area of the outlet passage, thus controlling the amount of oil delivered by the burner, but the helical passage is not affected. The single claim of the patent covers the combination of the adjustable nozzle "encircled by an adjustable annular opening

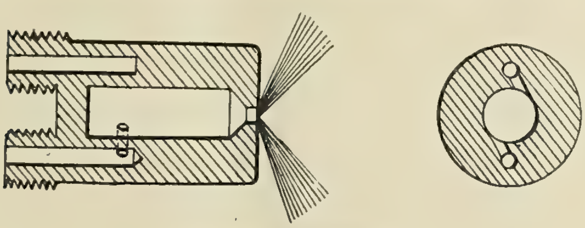


FIG. 4.—JONES BURNER

through which the air for combustion, supplied by a fan or blower and heated by the waste gases from the boiler, issues and mixes with the oil jets as they enter the furnace."

Howden does not claim the atomizer, and its similarity to the Schütte-Köerting burner shown in Fig. 33 is suggestive. The Schütte-Köerting burner, however, is not adjustable.

The idea of delivering the oil tangentially to a chamber inside the nozzle is shown in a burner patented in England by Mr. Albert Edward Jones in 1907 (Fig. 4). This invention, as a matter of fact, contemplates the use of a gas or vapor in

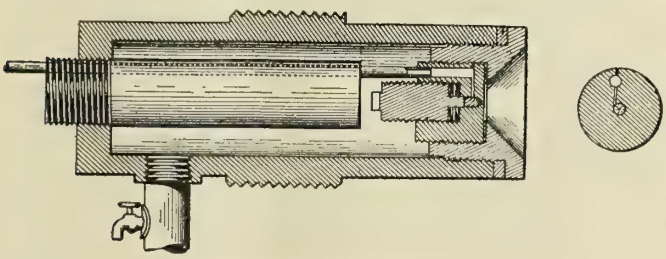


FIG. 5.—STRINGHAM-ELMENDORF NEBULIZER

combination with a combustible liquid, and is not strictly what we consider a mechanical atomizer, but the device is almost a diagrammatic illustration of the tangential principle, and for that reason I have reproduced it here. It may be considered that oil is forced into both tangential passages, or that only one is used, this depending only on the whirling motion of the oil to cause the spraying.

A so-called "nebulizer of the heavier hydrocarbons," patented in this country in 1908 by Stringham and Elmendorf, is a good illustration of the further development of the tangential principle, and is shown in Fig. 5. This apparatus was water-cooled, a precaution not found necessary in connection with boiler furnaces.

Modification or combinations of the tangential and helical forms of burners are frequently encountered in the art, and an illustration of one of these is shown in Fig. 6. This is an ingenious burner patented in England by Sir John Thornycroft in 1906, in which it will be noted that the oil passages within the tip are made variable in area of cross-section by an adjustment of the spindle, thus varying the quantity of oil delivered without alteration of either oil pressure or size of outlet passage. This renders the burner adjustable like the

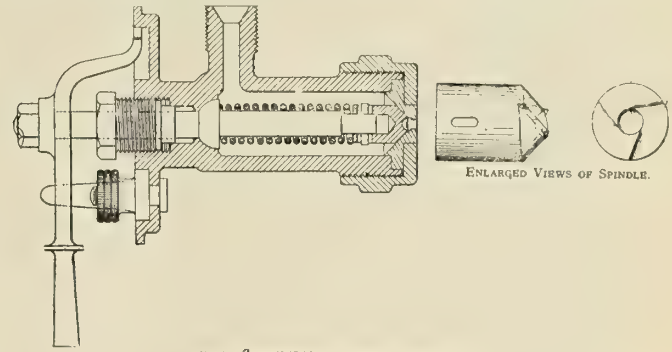


FIG. 6.—THORNYCROFT BURNER

Howden, though by a different process, in that in the Howden burner the helical passages remain unaltered and only the outlet orifice is changed.

Control of Capacity

This matter of adjustability of an oil burner; that is, the ability to change the quantity of oil delivered in a given time without changing the oil pressure or the velocity of the liquid through the tip, while attractive in idea, and perhaps well sustained in theory, has no particular value in practice. It is a fact that the simpler forms of burners which do not possess this feature are quite, if not more, successful in regular operation on shipboard. The manipulation of the oil pressure acting on all burners at once presents in itself a simple means for the control of output through a wide range; a good burner will atomize moderately heavy oil with an oil pressure as low as 30 pounds, and from that up to 200 or above. If this range is insufficient to meet the variable steam requirements, then it is easier and better to shut down a portion of the burners entirely than to attempt to adjust each individual burner separately, particularly as it is important to regulate the quantity of air for combustion admitted to the furnace at the same time the quantity of oil is varied. This air supply can easily be controlled for all burners by regulating the draft pressure, and the air can be closed off entirely when a burner is shut down. This puts the question of proper air supply more into the hands of the designer, requiring the operator to determine only the proper conditions of draft pressure for the plant as a whole at the required capacity.

Effect on Capacity of Heating Oil

Another means of varying the quantity of oil delivered by all burners in addition to alteration of oil pressure is available in alteration of oil temperature. Generally speaking, under working conditions any increase in temperature of the oil results in decreased capacity of the burners, the pressure remaining the same. The reverse is the case at low temperatures, the critical point depending on the relationship between viscosity and specific volume of the oil in question. This law is shown graphically in the diagram in Fig. 7, giving the results of a test on a sample of Texas oil of 18 "gravity" (degrees Baume) and a flash point of 240 degrees F. The oil pressure maintained constant throughout the test at 200 pounds, and the temperature was raised by stages from 80 degrees F. to the flash point. The burner capacity increased rapidly up to a temperature of 110 degrees, where it reached a maximum. With continued heating it began to fall off, and continued to do so throughout the range of the experiment.

Requirements of Mechanical Burner

It will be obvious, if oil is to be atomized by centrifugal force, that the best spray will be obtained by giving the oil the maximum whirling motion and reducing to a minimum the

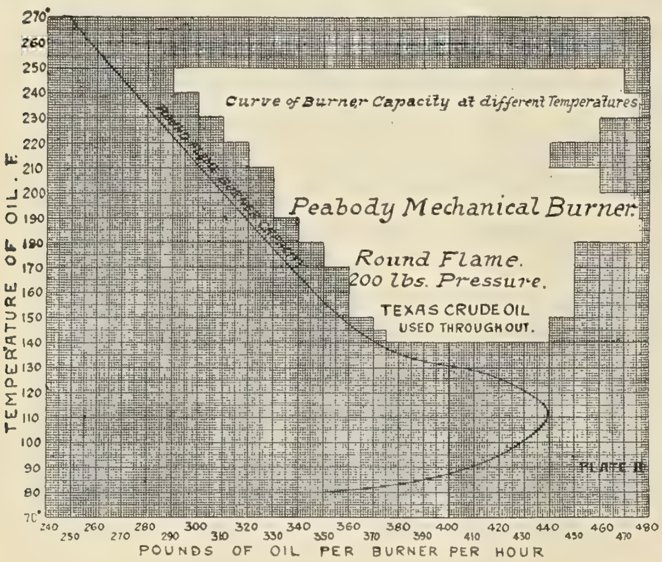


FIG. 7.—TEMPERATURE CAPACITY CHART

friction in the burner, so that the whirling motion once obtained shall not be diminished before the oil is liberated. These are axiomatic principles, recognized by all, and no doubt each inventor believes he has best met the requirements.

It seems to me that the tests are these—that these are the controlling factors in the "survival of the fittest":

1. How heavy an oil will a burner thoroughly atomize?
2. What pressure and temperature are necessary?
3. What degree of simplicity has been attained in the design?

Use of Heavy Oil

I might say here that any apparatus which will not handle heavy oil will have a very limited usefulness. Already the market is beginning to be supplied with very heavy oils from Mexico; there is considerable crude oil in California below 15 degrees gravity, and the tendency will be more and more to use the heavier residuums. I believe that in a few years we will be using oils of 12 degrees to 15 degrees Baume as commonly as we are consuming oil of 27 and 30 degrees gravity to-day.

The Babcock & Wilcox Company recently received from the Texas Company, for experimental purposes, some Mexican crude oil, having the following characteristics:

Specific gravity at 60 deg. F.	.981
Degrees Baume at 60 deg. F.	12.6
Moisture and silt	3.5
Flash-point	310
Burning point	347
B. T. U. per pound (oil as received)	17,551

In appearance this oil was black, and at temperatures of about 80 degrees very sticky and viscous. On heating to 212 degrees it turned to foam owing to the presence of so much water, and this failed to separate out, a sample of the oil being thinned down with ether to determine the percentage. Ordinary settling tanks would have been practically useless, as the oil was so near the specific gravity of water. This oil was, however, successfully sprayed and burned under natural draft on being heated to 270 degrees at a pressure of 165 pounds. A slight amount of smoke was formed, which disappeared on a slight increase in the furnace draft above twelve-hundredths inch of water. The most noteworthy feature of the experiment was that the capacity fell off about 40 percent from that obtained with the same apparatus with oil of 18 gravity.

This sample of oil was the worst the writer has ever seen, but they say there is more of it, and it is a specimen of what we may have to handle in the near future.

DENSITY OF OIL

Degrees Baume.	Specific Gravity.	Pounds per Gallon.
12	.986	8.22
14	.973	8.11
16	.960	8.00
18	.948	7.90
20	.936	7.80
22	.924	7.70
24	.913	7.61
26	.901	7.51
28	.890	7.42
30	.880	7.33
32	.869	7.24

The above table of densities is given for convenient reference.

Peabody Mechanical Atomizer

In the light of our experiments, begun in 1907, we have come to believe that the best rotative effect on the oil is produced by the tangential delivery method, and it seems plain that the best way to reduce friction is to reduce the amount of surface to which the oil is exposed in its travel through the burner after it begins to whirl and until its exit from the tip. We have also come to attach great importance to simplicity in everything connected with oil burning, and we believe that the oil burner itself should be of simple construction, easily taken apart, and so designed that when taken apart all the small passages and wearing surfaces will be exposed for inspection, cleaning and repair.

The results of the writer's efforts to construct a burner to meet these requirements are shown in Fig. 9. Oil is delivered under pressure to an annular channel cut into the face of a

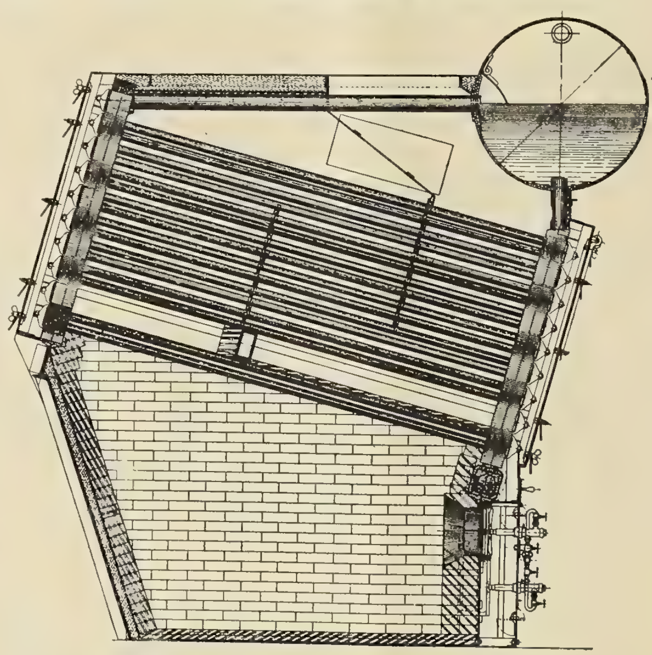


FIG. 8.—FURNACE OF BABCOCK & WILCOX BOILER

nozzle upon which is screwed a tip having a very small central chamber communicating with a discharge orifice. Between the nozzle and the tip a thin washer or disk is inserted and held firmly in place. This has a hole in the center corresponding with the diameter of the central chamber of the tip, and small slots or ducts, extending tangentially from the edges of the central opening outward toward the periphery of the washer, long enough to overlap the annular channel of the nozzle and put it in communication with the central chamber. The effect is that when the burner is assembled with the washer in place, oil is delivered through the ducts tangentially to the

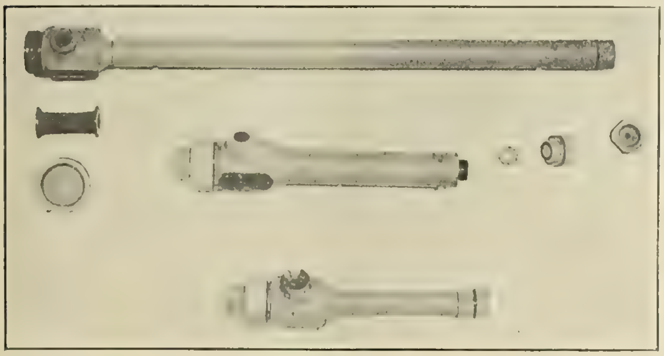


FIG. 9.—PEABODY MECHANICAL ATOMIZER

central chamber, where it rapidly revolves and almost immediately is discharged through the orifice in the tip.

Character of Mechanical Spray and Effect on Combustion

In order to correct a popular fallacy I beg to call attention here to the fact that no mechanical atomizer produces a re-

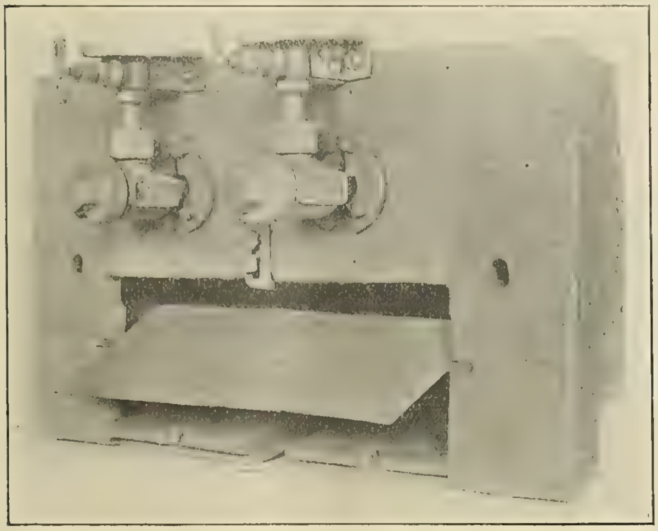


FIG. 10.—FITTING OF OIL BURNERS FOR COAL AND OIL FRONT

volving spray, but the particles of oil fly off in straight lines under the influence of centrifugal force, thus forming a hollow, conical spray. The fineness of this spray, *i. e.*, the minuteness of the particles forming it, has a most important bearing on the results obtained in the furnace. It is possible with some forms of steam atomizers to atomize oil so finely that no flame at all will be produced, the incandescent combustion chamber being filled merely with a clear, invisible gas and every brick being discernible. I doubt if this condition of flameless combustion can be produced with mechanical atomizers and heavy oil, nor is it desirable under any circumstances, for the simple reason that it costs too much.

With the production of flame, however, furnace design assumes an added importance, for the flame must be distributed evenly and without localizing on the heating surfaces of the boiler, and the gases must be given time and space in which to expand and burn as nearly as possible to completion before being cooled and the flame extinguished by contact with the tubes of the boiler. These points become exceedingly vital when the boiler is forced to the requirements now demanded in naval service.

Furnace Design

Having an atomizer, therefore, that will produce a fine spray with heavy oil, and which is simple, reliable and easily handled, the problem becomes one, not of oil burner, but of furnace design and air distribution. Our work has been carried on, until recently, entirely with the Babcock & Wilcox marine boiler, a design having a furnace ideally suited for any volatile fuel, and particularly for oil. A longitudinal section through this boiler fitted with mechanical atomizers is shown in Fig. 8. It will be seen that the characteristics of this furnace are: Large volume in proportion to the heating surface of the boiler; upward slope of the roof toward the rear, resulting in increase in height and volume in the direction of the entering oil spray, and thus providing room for the expansion and diffusion of the gases; small amount of boiler heating surface exposed, and, on the contrary, large exposed surface of incandescent refractory material, thus tending to maintain high furnace temperature and promote complete and rapid combustion of the oil; tubes almost parallel with path of the oil spray injected into the furnace from the front, thus promoting proper distribution of the gases along the tubes and preventing local overheating; outlet from the furnace at the point most remote from the location of the atomizers, thus insuring long travel of the gases, and, finally, means for bringing the heated products of combustion into the closest possible contact with the entire amount of heating surface of the boiler, discharging the waste gases into the up-take at temperatures but little above that of the steam generated. These conditions combined to relieve us of any worry about furnace design, or, to put it another way, we had been through all that before with steam atomizers.

Our experiments therefore developed principally into a search for the best method for admitting the air for combustion. (*To be continued.*)

Voyage of the Motor Ship Eavestone.—The Diesel-engined motor ship *Eavestone*, built recently by Messrs. Sir Raylton Dixon & Company, Middlesbrough, and engined by Messrs. Richardson, Westgarth & Company, Ltd., Middlesbrough, in conjunction with Messrs. Carels Bros., Ltd., Ghent, Belgium, has just completed a voyage of 3,701 nautical miles from Pomaron to Savannah, Ga., without a single stop. The steaming time was 18 days 18 hours 14 minutes, the average speed 8.2 knots and the average daily fuel consumption 3 tons 18 cwt. The total oil fuel consumed for the voyage was 73 tons 10 cwt. This vessel was fully described on page 405 of the October, 1912, issue of International Marine Engineering. Since she went into commission, however, a tank has been installed for compressed air from which the steering engine is driven while at sea. This installation has reduced the daily coal consumption for auxiliary purposes from 2 tons to less than 1 ton. The supply of air from the tank can hardly keep the steering engine going when the vessel is maneuvering in and out of port, but as soon as the vessel is placed on her course in the open sea the air tank furnishes ample power for steering the ship.

Monthly Shipbuilding Returns.—The Bureau of Navigation reports 88 sailing, steam and unrigged vessels of 32,879 gross tons built in the United States and officially numbered during the month of November, 1912. Eight steel steamships, aggregating 17,928 gross tons, were built on the Atlantic and Gulf coasts, and one steel steamship of 2,549 gross tons was built on the Great Lakes. The largest vessels completed in this month were the *Dakotan*, of 6,657 gross tons, built by the the Maryland Steel Company, Sparrows Point, Md., for the American-Hawaiian Steamship Company, and the *Lenape*, of 5,179 gross tons, built by the Newport News Shipbuilding & Dry Dock Company, Newport News, Va., for the Clyde Steamship Company.

McAndrew's Floating School

BY CAPTAIN C. A. McALLISTER*

CHAPTER III

Force, Work and Power

"Come on, boys, let's turn to and get right at this business," said McAndrew to his class, as they assembled on the following night. "The first part of this course is going to be what you all need the most—a little instruction in elementary principles. There is no good of a man trying to put a roof on his house until he has at least a pretty fair foundation under it. As I have already told you, I don't want to go into any 'high-brow' theories with you, as both of us would be losing something valuable—I'd lose my time and you would lose your interest.

"In all branches of engineering the principal output is power in one form or another. Now, it is a safe bet that none of you knows exactly what power is. I want to get the right idea of it firmly impressed on your memory, so that you will not be like a certain Irishman I know of who, through political influence, got a job to run a small steam engine in the Capitol. A sightseer stopped to look at his engine one day, and asked the son of Erin what horsepower it was. 'Horsepower!' he ejaculated, 'horsepower be ——; don't you see that it runs be stame.'

"Now to understand what constitutes power you must consider three elements—force, distance and time. For instance, here is a block of iron which weighs 5 pounds. I lift it up 1 foot from the deck by using *force* to overcome its weight, and in so doing I have performed *work*, which is measured in what is known as foot-pounds; that is, I have performed 5 foot-pounds of work by overcoming the weight of this 5-pound block through a *distance* of 1 foot. Now get that fixed in your mind, *force* is overcoming weight, and *work* is overcoming weight through distance or space. Now it wouldn't make any difference whether I lifted that 5-pound weight a foot high in a second or ten minutes so far as the term 'work' is concerned, but when you come to 'power' then there is another thing to be considered, and that is the *time* it takes to perform the work. In measuring anything you must have a standard upon which to base your measurements; thus you buy waste by the pound, oil by the gallon, etc., so the early engineers in looking for a standard on which to measure power quite naturally selected the horse, that faithful beast which carries or pulls all manner of burdens for mankind. As a result of experiments on a large number of horses in England many years ago, it was decided that at an average a horse could perform 33,000 foot-pounds of work in one minute; hence this was fixed as the now almost universally adopted standard 'horsepower' for all engines. Always keep in mind, therefore, that power consists of three things—force, distance and time. Later on I'll show you how to calculate the horsepower of an engine.

"The next foundation stone I want you to lay is to get the right idea of the so-called mechanical powers. Only the other day I heard Nelson say when he was working that small jack-screw, 'Gee! but this is a powerful little beggar.' Don't forget one thing right at the start; there never has been any kind of a machine invented where you can get more *power* out of it than you put in it. In fact, it is always a little less on account of the loss by friction. If that jack-screw appeared to lift a weight of several tons with comparative ease, you must remember that it only lifted it a few inches, while your hand traveled a good many feet in working the bar. The fundamental principle of all the mechanical powers is that the weight, multiplied by the distance it moves through, is always equal to the force multiplied by the distance it moves through. Suppose we take this foot-rule and put it over a knife-edge on the 4-inch mark. On the short end we will put these two 1-inch nuts and on the long end we will put one such nut, and you see that they balance exactly. Why? Simply because $2 \times 4 = 1 \times 8 = 8$. That is the principle of the lever, and later on you will find that it is the principle of the lever safety valve about which you will have to know before you can ever get your 'ticket' from the steamboat inspector.

"The next thing you want to understand is the inclined plane. Suppose you want to put a barrel of oil on a truck. You can't lift it off the deck, so you go and get a plank, and, single-handed, you can roll it up and put it in the truck. How could you do it? Simply because you couldn't lift it bodily a distance of perhaps 3 feet you rolled it up a plank 10 feet long. In that manner, while the barrel was lifted vertically 3 feet, you were shoving it for a distance of 10 feet.

"A wedge is simply a double inclined plane; to open up a space ½ inch wide in a plank you often have to drive the wedge lengthwise eight or ten times that distance.

"The screw, such as that jack I was speaking of, is a combination of the lever and the inclined plane. When you take hold of the end of the bar and pull, it acts as a lever on the head of the jack-screw. The thread is simply an inclined plane wrapped around the bolt. Between the two you can exert a tremendous pressure to lift anything, but always remember the great number of times you have to pull that bar around, and compare the distance your hand travels with the short distance the weight is lifted, then the 'tremendous pressure' exerted won't seem to be so mysterious.

"There are several other so-called mechanical powers, but they are all practically based on the principles of the lever and the inclined plane.

"No matter what tool or mechanical contrivance you are using, just try to reason out on the principles I have given you to-night how you are accomplishing the work. To-day, O'Rourke, when you were lifting that main-bearing cap, you know that you couldn't budge it alone, but you had no trouble in hoisting it up with the chain tackle. How do you account for that?"

O'Rourke scratched his head a bit and said, "Come to think of it I guess I did pull that chain about a mile before I got the cap up a foot; the next time I'll let the Dutchman 'hist' her up, while I take observations on how far he has to pull it."

"I see," said McAndrew, "that you'll make good as a scientist, as the first thing any of them learn is to let some other fellow do the manual labor."

CHAPTER IV

Heat, Combustion and the Generation of Steam

"Having told you something about mechanical powers, I now propose to continue still further my remarks on elementary principles, and will take up the subjects of heat, steam, combustion, etc. In starting off I will ask you what is steam?" As no one else seemed to volunteer an answer, O'Rourke blurted out, "It's a white gas that kills you if you breathe it."

"It will kill you all right, but please remember that steam

* Engineer-in-Chief, U. S. Revenue Cutter Service.

is not white until it is condensed into small particles of water —when it is formed in a boiler it is as colorless and invisible as the air. I am afraid, however, that your idea of steam is somewhat cloudy. Of course, you all know that when you shovel coal in a furnace, and boil the water in the boiler, steam is formed; but how? is the question.

"Heat, scientific men inform us, is a mode of motion. All substances are composed of infinitesimal small particles called molecules. Heat is the violent motion of these molecules, and may be occasioned in two fundamental ways. The first is what may be termed chemical action or combustion, and that is what interests us most. The element known as carbon, of which coal is largely composed, unites with another element known as oxygen, and heat is generated. Thus we put coal containing carbon in a furnace and admit air containing oxygen through the grate bars, and heat results from the chemical union of the two elements. They must unite in certain proportions, so that is the reason you have to regulate the dampers and ash-pit doors. The right proportion is one part of carbon and two parts of oxygen. Always remember that the air is just as essential in forming heat as is the coal."

"The air is much easier shoveling," broke in O'Rourke. Not paying any attention to the interruption, McAndrew continued: "The right kind of a fireman is the one who pays attention to his fires and allows the proper mixture of air to reach the fires. If you put in too much coal, such as the 'crown-sheeters,' which O'Rourke likes to carry, the air does not have sufficient chance to circulate through the hot coals to make good combustion. If the clinkers and ashes are allowed to collect on the grates, they also shut off the proper amount of air and your fires get dead. Hence the best way to make steam is to carry a fire of uniform thickness, not more than 6 to 8 inches deep, and by means of the slice-bars keep the ashes off the grates as much as possible. Another thing is to keep your doors shut as much as you can; too much air is as bad as too little. When you have to throw in coal do it quickly, and spread it evenly over the fires. If the conditions are such that there is one part of the oxygen to one of carbon, you will not make much steam, as such a mixture does not burn—simply smells bad.

"As I told you before, there is a method of measuring everything by comparing it with some standard. This applies to heat as much as it does to coal itself, only you do not measure heat by its weight, as it has none; therefore we must measure it by its effect. One of the effects of applying heat to metals is to cause them to expand or grow larger. Taking advantage of this quality the thermometer was invented, which records the expension and contraction of mercury in a glass tube as heat is applied. While the thermometer measures the degree of the heat in a relative manner it does not measure the amount. Hence a unit amount of heat was decided to be the amount necessary to raise 1 pound of water 1 degree on the thermometer. They call that amount a British thermal unit."

Schmidt was very much interested in this term and remarked, "I suppose O'Rourke would rather have it called an Irish unit."

"Now it may interest you to know that a pound of good coal ought to produce something more than 13,000 of these British thermal units. Remember that, for by the time you boys get to be chief engineers everybody will be buying coal by the number of British thermal units it contains instead of specifying some particular brand of coal, as is done now. If you are not buying coal you will be buying fuel oil; but even so you will want to know the thermal units it contains.

"In order not to give you any wrong impressions as to the amount of air necessary for combustion, I want to tell you that for every pound of average coal there are needed about two and two-thirds pounds of oxygen. As the air contains only about one-quarter of its weight in oxygen, it is usual in order to obtain a good draft to admit about 20 pounds of air to the pound of coal. That means that approximately 250 cubic feet of air must be admitted to the furnaces for every pound of coal that is burned. Fortunately, the air costs nothing, or the process of making steam would be very expensive. Although I have advised you to keep the furnace doors open just as briefly as possible, do not forget that some air must be admitted above the fire in order to attain proper combustion. In all well-designed furnace fronts you will find a number of holes for the admission of air, so you must see that they are kept open.

"Now as to the other method of generating heat. All of you have noticed that if you rub your hand briskly over a smooth piece of wood, for example, there is a sensation of warmth. That is due to the energy you exert in the rubbing process. If you do not keep a crank-pin well oiled you know that it will soon become heated up, and if it is allowed to go far enough it is quite possible that sparks would fly or the metal become so heated as to show color. This is but another example of energy being transformed into heat. You all know that the heat from the steam is quite readily turned into power or energy in the engine, so there must be some standard system of comparing one with the other. I have already told you that work is measured in foot-pounds, and that heat is measured in British thermal units. A scientific man named Joule therefore determined that 772 foot-pounds of work was equivalent to a British thermal unit, and that is the way that comparisons are made. O'Rourke, you are quite a strong young man, but you can see that if you hustled as fast as possible, you would not be able to turn out as much work as even 1 pound of coal. That shows you the difference between using your muscles and your brains. Coal is a very cheap and able competitor of the man who only uses his physical strength, but fortunately for mankind brains cannot be bought so cheaply.

"We have seen how heat is generated from coal, and you must keep in mind that heat is the source of all power for marine propulsion. Water is found to be the ideal means of conveyance for transforming the heat into power; it is easily converted into steam and it exists in great abundance. Hence the large majority of marine engines are designed to work by steam generated from water. You know that the result of starting fires in a boiler containing water is the generation of steam. If you put a thermometer in the boiler water you would see that some time after the fires are started the temperature would gradually rise until it reached the boiling point, usually taken at 212 degrees above zero. The heat thus applied is known as sensible heat, from the fact that it is apparent to the senses. After having reached that temperature it takes considerable time until steam is finally formed. This is due to the fact that for water to be turned into steam a great amount of heat is necessary to break up the liquid water and transform it into the vapor—steam. The heat thus absorbed by the water in the transformation is known as the 'latent' heat. To bring about this change there are required 966 British thermal units per pound of water, while it only took 152 British thermal units per pound of water to raise it from the temperature it was put into the boiler, say at 60 degrees, to the boiling point."

"Does this latent heat burn you as much as the other kind of heat?" said Pierce.

"Try it and see," replied McAndrew. "If you stick your hand in water at the boiler temperature I don't believe you will care whether the heat is 'sensible' or 'latent.' "

"If he's sensible I think he will keep his hand out of it," broke in the irrepressible O'Rourke.

"Now," continued the instructor, "you have sometimes heard the expression 'saturated' steam, and I suppose you think that something must have been mixed with it; but that is not the meaning at all. It really means steam in its natural condition; that is, for every pound pressure on the boiler there is a certain temperature corresponding."

O'Rourke whispered to Schmidt, "I'm on; now I know why they say a man is 'saturated,' like that drunken oiler we had last trip; it was *his* natural condition all right."

"If more heat is added to the steam than is due to that of its pressure then we have what is known as 'superheated' steam; and people are waking up to the fact nowadays, after discarding the use of superheated steam years ago, that there is real economy in it. I think that before long you will see nearly all marine engines using superheated steam.

"If the steam was generated under an atmospheric pressure only, a cubic inch of water would form 1,663 cubic inches of steam. To memorize that fact keep in mind that a cubic inch of water will make nearly 1 cubic foot of steam. Don't follow that rule too strictly, or some time you may be as badly off as the old lady who, when asked for a pound of shot and not having any scales, remembered the old rule, 'A pint's a pound the world around,' and gave the purchaser a pint of shot. Right here let me warn you about using these old approximate rules too freely unless you really understand why they are used and know the correct ones. Engineering is an exact science, and it does not pay to guess at anything.

"Steam, however, is not generated in boilers under atmospheric pressure; therefore I want you to know that while water will begin to boil at a sensible heat of 212 degrees when the steam is unconfined, as the pressure rises, the boiling point is raised correspondingly. Thus at 20 pounds pressure it will not boil until the temperature is 228 degrees, at 50 pounds pressure 281 degrees, at 160 pounds 363.6 degrees, and so on. Perhaps I should tell you here that the pressures I have given are what are known as absolute pressures, and I surmise that you do not know what that term means. It probably has never occurred to you that air weighs something; you breathe it and move through it as if it did not cause any particular resistance, but the pressure is there just the same. Now to understand it you must consider that the atmosphere we move around in is similar to water; the deeper you go in it the greater is the pressure, but as we are generally at the bottom of the air, which is at the level of the sea, we usually have the greatest pressure attainable, and it amounts to 14.7 pounds per square inch. In some foreign countries they speak of the pressure on the boiler not as so many pounds per square inch but as so many 'atmospheres.' Thus a pressure of 10 atmospheres, you can quite readily understand, is ten times 14.7 pounds, or 147 pounds gage pressure. If you were at the top of a high mountain, the air pressure would not be so great and water would boil at a less temperature than 212 degrees. The steam gages on a boiler always record the pressure above the atmosphere; hence to find the absolute pressure of steam you must add to the apparent pressure shown on the steam gage the constant 14.7. This is important for you to remember, for later on when we get to talking about pressures in triple-expansion engines and turbines you must forget about steam-gage pressures and deal in absolute pressures."

"How is it," asked Schmidt, "that this atmospheric pressure don't crush in our ribs?"

"That's a good question," replied the Chief, "and I'll answer you by asking you one. How is it that a thin box without a lid on, sunk at the bottom in 25 feet of water, is not crushed by the water pressure? I'll also tell you the answer, and that is because the water is on both sides of the walls of the box, and it is consequently balanced. So with the human system, we breathe air and get it inside of us and there is a balance. Now if that thin box had a lid on it and was watertight the sides would be crushed by the water pressure."

"Gee!" interrupted O'Rourke, "I'll keep my lid off after this! I don't want my sides crushed in!"

"No danger of that," retorted Schmidt. "You are not watertight—you've got a leak in your throat."

"Following this discussion on the pressure of air, we might as well take up the question of 'vacuum' and get a good idea of that. O'Rourke, what do you understand is meant by a 'vacuum'?"

"Why—er—let me see," replied the talkative one. "Why—er—it's something in the condenser that sucks in your hand if you put it over the air cock."

McAndrew smiled and said, "No; it is something that is *not* in the condenser, and your hand is not 'sucked in' but forced in by the pressure outside; otherwise, O'Rourke, your answer is excellent. You made two guesses and got them both wrong. You might have gone further in your lucid description and said that it was something which smelled bad. The term vacuum really means the absence of air, or the absolute zero of pressure. I have just told you that the air under normal conditions, at the level of the sea, weighs 14.7 pounds per square inch. Now if you pump out all the air from a box or other receptacle there is no pressure in it because there is no air. If a small amount of air is allowed to rush in there will be, naturally, a small pressure, but how much? That is what we want to know, as there must be some means of measuring it. You all have learned undoubtedly that this ship carries 26 inches of vacuum when we are running. That comes from the fact that some early scientific fellow learned by experiment that the pressure of the atmosphere (14.7 pounds per square inch) was the same as the weight of a column of mercury, or quicksilver, as you may know it, 29.74 inches in height. In ather words, a perfect vacuum, or the absence of all air in a condenser, would be shown on the vacuum gage as 29.74 inches. If a small amount of air be admitted the needle on the gage would show a vacuum of less than that, as the balance between the air and the mercury would be disturbed. Finally, if the condenser was opened so that air could rush in freely, the needle would go back to the zero mark. It is customary, therefore, to speak of carrying a vacuum of so many inches, but don't ever speak of having a vacuum of over 30 inches, or people will think you are foolish. As a matter of fact, it is quite difficult on ordinary ships to get a vacuum much over 28 or 28½ inches. As 2 inches of vacuum is equivalent to 1 pound of pressure you can see how valuable it is for the working of the engine to have as great a vacuum as possible.

"While on the subject of vacuum, it will be well for us to take up the subject of how far a pump will lift water. After all this is very simple, as the pump does not lift the water at all; it simply pumps out the air, and the air pressure from without forces the water up the suction pipe. On the same principle as the column of mercury, it has been determined that the unit weight of air (the atmospheric pressure) will sustain the weight of a column of water about 33.5 feet in height, and that is the maximum height that water can be lifted by a pump, so never try to pump water through a suction pipe any higher than that. You can *force* it to almost any height necessary, but you can't *lift* it any higher than 33.5 feet. There is an old saying that 'Nature abhors a vacuum.' It is not so much an abhorrence as it is the universal tendency of Nature to maintain things in an equilibrium or balance. If you disturb this balance by removing the air from anything, the outside air, water or whatever medium it is, will rush in to restore the equilibrium."

Just then, Pierce, who had been leaning back in his chair, intensely interested in what was being said, fell over backwards, much to the amusement of O'Rourke, who remarked, "There she goes again; Nature is restoring his balance!"

(To be continued)

What Constitutes a Steamship Terminal*

BY H. McL. HARDING†

The importance of terminals, not only for water, but also for rail transportation, has only lately been fully comprehended. When it is stated that of the $1.59 (6s. 7½d.)—the transportation expense of a ton of freight of a certain classification between New York and Galveston, a distance of 2,000 miles—80 cents (3s. 4d.) represents the terminal expenses, and the remaining 79 cents (3s. 3½d) all the carrying expenses, it is evident that the subject is well worth attention.

When the cost at the New York and Washington freight terminals in rail transportation is at least double all the costs of carrying between these two cities, it is of some interest to secure full information.

Finally, when in these days of agitation against high transportation rates, it is stated by two of the most important business men in a Western city located on the banks of the Mississippi, who are most friendly to water transportation, that after repeated trials the terminal expenses employing manual labor from the boat up the levee to the top of the bank was more than the saving of water over rail carriage, evidently the question of terminal improvements, especially on our inland rivers, cannot well be postponed for future consideration.

In one case where the material was floated down the river on a raft belonging to one of these men, and costing nothing for carriage, the terminal expenses were more than the saving effected by no cost of carriage.

Most remarkable figures have been submitted as to the influence of the cost of transportation upon the cost of living, and, as has been proverbially asserted by the president of the New York Central Railroad, "the cost of transportation affects every man, woman or child who wears clothing or eats food." None can escape it, the greatest or the least.

As the total of terminal charges as shown is such a large proportion of the transportation charges, terminals should no longer be regarded as the appendix of transportation, but as of equal value with the channel and the steamship, the rail and the locomotive.

Although reference to the economy of terminals has been given first, yet by most transportation managers economy at terminals is subordinated to rapidity; that is, rapidity of movement is considered even more essential than economy.

The charter value of a large coastwise steamship may be $400 (£83 6s. 8d.) per day. One day saved on the time of one ship's trip represents no inconsiderable amount. On a fleet of a dozen vessels it means increased dividends.

On the inland rivers, where there are a number of landings to be made on each trip, and where by means of powerful searchlights night travel can now be made as quickly and as safely as by day, rapidity of movements attained by electrical transferring machinery, requiring few men, indeed, on the vessel or the shore, signifies many more trips per season, and may add that one thing which was needed to round out the full measure of successful inland water transportation.

Provided there are complete terminals with no terminal elements lacking, the greater possible rapidity of river-terminal freight movements over possible rail-terminal movements can often more than equalize the greater speed of the locomotive over the "power boat."

A thousand tons of miscellaneous or package freight from a properly designed barge can be discharged, including assorting and distributing according to consignments, in but a fraction of the time it would require to unload 1,000 tons of such freight from over 100 freight cars. Not only so, but the barge-loading and discharging can go on simultaneously. Hence

1. Greater freight transferring rapidity at water terminals over that at rail terminals can more than neutralize the advantages of the greater speed of rail carriage over water carriage between the terminals.

2. Possible water-terminal saving in freight transferring over the expense of rail-terminal transferring can be made more than even the saving in water carriage over rail carriage for the average trip distance.

3. Properly designed and mechanically equipped terminals, co-ordinated with land transportation, are vital to the competitive success of water transportation.

While the type of boat may not come within the province of terminals, yet a boat not suitable for quick loading and discharging should not be adopted if rapidity and economy are to be attained. It may be said that the steamboat on the rivers should be for passengers, but the power boat with barges for freight.

There should be in one tow large steel barges for large cities, smaller barges for the towns and villages, and the smaller barges divided into sections, each section representing a small village or landing. The discharging, assorting and distributing should be performed by one continuous operation of the machinery.

At the largest cities a barge to be discharged is left and a full one taken. The power boat is the locomotive and the barges are the freight cars, some of which, as on the German rivers, may have a capacity of from 1,000 to 3,000 tons, each equal to that of a coastwise steamship.

The tonnage will often be limited by the river's depth. An 800-ton barge can be towed where there is only 6 feet of water.

Some barges may be regarded as floating terminals. The freight can be loaded directly into them by electric machinery as received from the shipper, and be assorted and distributed according to consignments when discharged by the same type of mechanism.

There are many elements of a successful terminal, and these differ according to the location.

General Plan for Initial and Future Development

After it has been approximately determined what will be the tonnage to be handled at a terminal, then the lengths of the lineal frontage can be estimated, the dimensions of the various sheds and warehouses closely determined, the length of the storage tracks and the amount of the machinery to give the necessary transferring capacity.

The Structure of Piers, Bulkheads and Quay Walls

The nature of the structures should largely depend upon the importance of the terminal. For the larger terminals along the inland rivers there are recommended concrete quay walls; at those of terminals of medium size, concrete or reinforced steel piling; and at the smaller terminals, wooden piles and trestles, the lower portion of which should be properly treated.

Transshipment Sheds

It may be said that transshipment sheds upon piers should be of one story, 40 feet in height, their length and width depending upon the location.

* Abstract of a paper read before the National Rivers and Harbors Congress, Washington, D. C., Dec. 4, 1912.

† Consulting Engineer, Department of Docks, New York, N. Y.

The function of transshipment sheds is chiefly as a place for the purpose of transshipment to other steamships, to barges and lighters for temporary holding, for inspection or distribution, or as a passageway to the transfer sheds or to the warehouses.

The transshipment sheds are not to be used for the storage of freight, and should be kept as free from hold-over freight as possible. Such freight as must be held for twenty-four hours or more for transshipment should be tiered high to economize floor space and to avoid congestion. By the installation of transferring machinery such freight as is often held within the transshipment sheds because there is no other place for it, or on account of the great expense of moving by manual labor, can be taken directly to the transfer sheds or warehouses for storage at small expense.

Transfer Sheds

To the rear of the projecting piers and transshipment sheds are the transfer sheds for the transference to and from the cars or drays, and for a shorter time storage than the warehouse storage. Within the lower section of such transfer sheds may be the railway tracks and platforms, dray areas and dray platforms. Longitudinal openings extend the whole length of the sheds between the upper and lower sections. As there can be a large number of transfer sheds, certain of these can be rented for the exclusive use of merchants or transportation companies instead of transshipment sheds, which is the usual custom.

Warehouses

To the rear of the above sheds, more remote from the water's edge, may be the warehouses for long-continued storage. These will be of several stories, the lower story being reserved for the car tracks and dray platforms. This lower story is 14 feet in height, and the upper stories of sufficient height to permit of high tiering. Other buildings and structures, such as power houses, coal trestles and elevated coal pockets, should be provided where the terminal is of sufficient size. There should be cold storage warehouses and market sheds. The terminal industrial section, the private industrial section and the residential section form part of a complete terminal.

Correlation of Terminal Elements

All the elements of a terminal should be connected or tied together by surface railway tracks and overhead transfer tracks. It should be possible to move freight between the vessel, the different sheds and warehouses, by mechanical methods, including assorting, distributing and tiering. To perform the different freight movements rapidly and economically by mechanical methods is an essential requisite to a successful terminal.

Conditions to be Fulfilled by Any Freight Transferring Machinery

There are three great principles in cargo transferring or freight handling, which must pertain to any machinery to fulfill all terminal conditions. These constitute the touchstone by which any machinery should be tested to determine its value:

1. That the machinery itself should be able to serve every cubic foot of space (which is to be utilized).

2. That the machinery should do this without any rehandling by manual labor.

3. That there should be continuous rapidity.

If, due to peculiar conditions, all these cannot be fulfilled, then as many as possible.

Freight movements consist in the receiving, inspecting, assorting, scribing, starting, calling, weighing, routing, distributing, checking, stowing and rechecking, all of which should be provided for in the most economical manner.

Types of Machinery

The types of machinery which pertain to miscellaneous or package freight consist of moving platforms, slot conveyors, portable conveyors, tiering machines, link belt conveyors, rubber belt conveyors, overhead chain and hook carriers, ramps, horse, motor and derrick trucks, winches, elevators, cranes such as the fixed jib cranes and pillar cranes, or the movable cranes as the gantry, walking or the traveling shop crane, transporters, overhead carriers, telphers, man trolleys, transfers and many others.

Attention is called to the latest types, especially to those used at German and English terminals. These devices consist in overhead trackage and transferring and hoisting machinery. There are two leading types which will be described. The power is electricity, preferably of direct current of 250 or 500 volts, and can be rented economically from the local electric light and power companies.

In one type the overhead tracks consist of an I-beam supported from the structure of the building, or if outside, upon bents. Upon this I-beam or upon one side of the lower flange, with an intervening strip of wood between, is placed a T-rail upon which travels the conveying mechanism.

In another type the rails are placed upon the lower flanges of the I-beam, but, although this type has many uses, it is difficult to serve the whole area between the fixed side tracks.

In the sheds the whole of the main side trackage is fixed in a permanent position, but the cross trackage is fixed or movable, and when movable, being attached to a traveling crane and so arranged that the hoisting and transferring mechanism can pass from any point of the fixed side tracks to the movable cross track, and then upon the fixed track on the other side, and thus complete the circuit of the movements.

This conveying mechanism consists of a transfer tractor which draws after itself from one to four trailers, each trailer supporting an electric hoist. This transfer tractor constitutes the traveling conveying mechanism, having a speed up to 9 miles an hour with its complement of trailers and 6 tons of freight. It is controlled in the same way as an electric trolley car, by a transfer man in the transfer tractor cab operating a drum controller, the current being taken by a contact wheel from a wire or other conductor located parallel to the track in the most convenient location, or in some special cases by a storage battery attached to one of the trailers.

Each trailer has suspended beneath it an electric hoist, which might be called a traveling electric winch. It has all the functions of the winch except that it is movable. The normal load of each hoist is 2 tons at a speed of 60 feet per minute. There is a reserve capacity of 50 percent. The hoists, when coupled together in pairs, can lift 4 tons. One ton would be hoisted at a speed of approximately 120 feet per minute.

The three hoists would therefore have a combined capacity of 6 tons, not including the reserve. The hoists are also equivalent to traveling elevators. This conveying and hoisting machinery contains no new mechanism, and can be furnished by a number of manufacturers.

This transporting machinery consists of two essential features—one mechanism which conveys and another which hoists, and this mechanism is able to transfer the freight with one conveying movement.

Operating Costs by Machinery

The sections of a terminal as they are developed will be connected by overhead runways, so that the same transfer tractors and trailers can be used upon different sections.

Although the cost of transferring freight will largely depend upon its character—that is, upon the relative proportion of its bulkiness to its weight—yet the actual cost of hoisting and transferring should not average more than 6 cents (3d.) per ton for a complete cycle. This does not include the expense at each end of the movement—that is, before the hoist hook is attached, or after the load is deposited, which on the average should add from 6 to 8 cents (3d. to 4d.) additional.

The 6 cents (3d.) for hoisting and transferring may be divided as follows:

Labor, 15 percent of transference cost. Interest and amortization, 30 percent of transference costs. Electricity, 20 percent of transference costs. Maintenance, 20 percent of transference costs. Incidentals, 15 percent of transference costs.

It must be emphasized that all such figures must vary under different conditions or locations, but there will not be, on the average from many places, a wide variation.

The cost of manual labor per ton for miscellaneous freight is from 36 cents (1s. 6d.) upward. The following figures, although often used, will serve as a general guide as to the expenses at the most expensive seaport in the United States:

Present Manual Labor Costs, Handling 2,000 Tons in 17 Hours.—Loading costs per ton. Labor only, including tiering, 36.6 cents (1s. 6.3d.).

Discharging cost per ton. Labor only, including tiering, 39.15 cents (1s. 7.58d.).

Mechanical Operating Costs for 2,000 tons in 17 Hours.—Loading costs per ton. Labor only, including tiering, 13.028 cents (6.51d.).

Discharging costs per ton. Labor only, including tiering, 14.575 cents (7.29d.).

Advantages of Mechanical Transference

The advantages of mechanical transference may be summed up as follows:

1. Greater rapidity of loading, unloading and distributing. The time of transference can be reduced by one-half or less in comparison with manual labor.
2. Economy per ton handled. A saving effected of more than one-half.
3. Increased holding or storage capacity.
4. Greater working capacity.
5. Less car detention and demurrage, meaning fewer cars to transport a given tonnage.
6. Saving in terminal investment.
7. Improved dray service and reduction in damage claims from breakage.
8. Reduced yard switching charges.

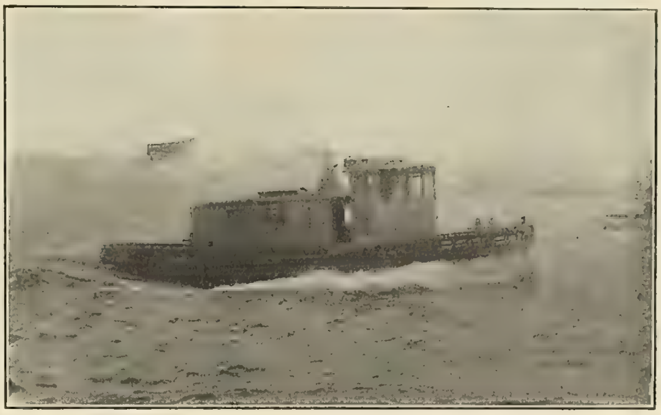
Conclusions

From the above it may be deduced that a complete terminal for water transportation should consist of a combined water and rail terminal with large land and water areas, with many feet of lineal water frontage, piers or quay walls, of sheds, warehouses, car tracks, dray areas and platforms. There should be industrial and residential sections and trade markets, closely allied to the terminal. All of these should be so equipped with modern transferring machinery that cargoes can be rapidly, economically and continuously transferred without rehandling from one terminal element to any other.

TEST OF A RUMELY MARINE OIL ENGINE.—A 125-horsepower, six-cylinder, compressed air-starting and reversing marine engine, built by the M. Rumely Company, La Porte, Ind. (for description see page 126 of the March, 1912, issue of this journal), has been run under severe test conditions for seven months, developing a maximum of 170 brake-horsepower. All of the tests were run on 5-cent kerosene (paraffin), and most of the time the engine was under a load of 145 brake-horsepower, running at 350 revolutions per minute. The fuel consumption at this power was .71 pound per horsepower-hour. Starting (with 50 pounds air pressure) is instantaneous, and reversing is accomplished from full speed ahead to full speed astern in three seconds.

A Mietz & Weiss Motor Tug Boat

A new development in the internal-combustion engine for tugboats, as well as for good-sized freight or passenger boats, is indicated in the accompanying photograph, which shows a tugboat 53 feet long by 12 feet 6 inches beam by about 5½ feet depth, equipped with a four-cylinder Mietz & Weiss reversible oil engine. This engine is of the two-cycle type in which the preliminary air compression for scavenging takes place in the crank case. It is well known that the reverse gear which has brought about the application of the small internal-combustion engines in thousands of boats is not suitable for the large sizes, because the output of the engine increases at the square of the diameter of the pistons, while the requirements for the clutch go up in direct ratio of the horsepower, which means that we do not have to go up very high in horsepower before the clutch becomes larger than the engine. But apart from this there is naturally a tendency, and particularly for marine work, to simplify the mechanism to increase its reliability. The two-cycle engine is particularly desirable with its impulse every turn for a marine engine. It reduces the weight, and is productive of almost constant torque at the propeller shaft.



TUG BOAT FITTED WITH REVERSIBLE OIL ENGINE

For certain reasons that are to be considered in a two-cycle engine, the controlling lever which admits the air to the distributor must, on its first movement, cut out the oil injections, so that the minute air of higher pressure than the atmosphere is admitted to the cylinders; there is no charge formed which might then bring about an abnormal pressure. The mechanism is therefore arranged so that the oil injections are positively locked at the first move of the lever for either direction of rotation. A further movement of the lever admits air in whatever direction of rotation the engine is supposed to run, and not until the engine is in motion will the oil injections take their regular course from the pump, which is controlled by the governor, to the cylinders in their various sequence.

The distributing valve is nothing but a rotating valve driven by the shaft of the engine with ducts cut in the casing to admit the air to the three or four cylinders, whichever the engine might have, in the proper order of its rotation. The controlling lever, which is attached to an ordinary two-way cock, admits the air, either for forward or reverse or in its central position shuts it off entirely. There is no other mechanism necessary, and inasmuch as the engine shaft is directly coupled to the propeller shaft there is no fly-wheel required, and as a matter of fact the engine in its outward appearance resembles a steam engine rather than the ordinary internal-combustion engine with its clutch and fly-wheel.

One feature of this engine should be mentioned, and that is the speed reduction that can be had by the throttling lever. By the throttling lever, which acts on the injection pump, and which in this case brings it down to about 80 to 100 revolutions per minute, at which the engine can be going constantly, just barely to move the boat, while the maximum speed at full force is 340 revolutions per minute.

Engines as high as 400 horsepower are at the present time put out by the builders under certain rigid guarantees as to oil consumption, manipulation and general performance. Units of 200 horsepower in cylinders 14 by 18½ inches, and units of 100 horsepower in single-cylinder engines, 18 by 27 inches, with a speed of 180 revolutions per minute, are also built.

Stability of Ships—Notes for Commanders

BY GEORGE NICOL

In the year 1883 the *Daphne*, a little steam vessel building on the River Clyde, capsized while launching, causing great loss of life. This was probably the greatest disaster in the annals of shipbuilding up to that time; certainly it was an event that marked the beginning of an epoch in the design of merchant vessels. The stability of ships, from being a subject of academic interest merely, became one of first-rate practical importance, and in the decade following the *Daphne* disaster more original research work was done in this branch of naval science than in all the years before. Shipbuilders were at last awakened to the importance of this element in design, and stability calculations became the everyday work of the drawing office. Nowadays, most men with a shipbuilding training are versed in the principles of stability, and it is not too much to say that repetition of the disaster of 1883 is very unlikely indeed.

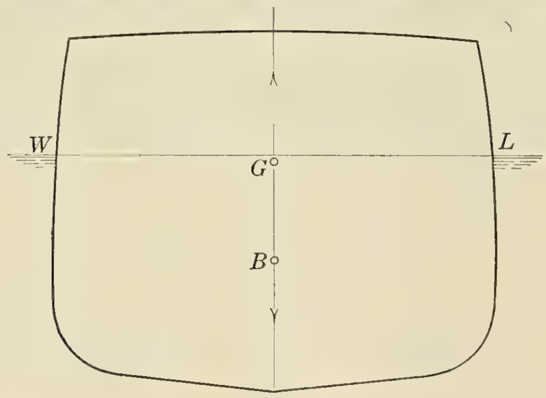


FIG. 1

FIG. 2

But a ship is only on the threshold of her career when she leaves the builder's hands. We now know that however well designed a vessel may be, she may yet not be immune from calamity if badly managed afloat. By injudicious loading a good ship may give no end of trouble and its very existence may be endangered. It has taken the shipping public a long time to grasp this. Disasters innumerable there have been. the evidence concerning which has pointed to insufficiency of stability; but other causes have been brought in to confuse the issue, and the main cause has thus escaped receiving the attention it deserved.

In some cases, however, in that of the *Waratah*, for instance, instability was so obviously the cause of the loss that the court could come to no other finding. It is to be hoped that something will now be done to deal effectively with the question of the stability of a loaded ship—to deal with it in such a way as to render unlikely the putting out of any ship to sea in a dangerously unstable condition.

The problem presented here is not an easy one. Not that the principles of stability are difficult, nor yet their application to this special case, but that few of the men who control the loading of vessels, however skilled as packers, possess even the most rudimentary knowledge of the stability of floating vessels. The problem then is one of how adequately to educate stevedores and commanding officers in this—to them—all-important subject.

The crux of the difficulty is the absolute lack on the part of such individuals of essential elementary knowledge of mechanics and hydrostatics. It is idle to talk of figures to one who has not mastered the multiplication table, but not more so than to speak of a moment of stability to a man who has never heard the term moment employed otherwise than as a measure of time. In the writer's view, no progress will be made until men in charge of the loading of ships have suitable theoretical training. To many the word theoretical is alarming. What does the practical man want with it? say they, with emphasis on the *practical*. This is a grand mistake. Theoretical training is more essential to the practical man than to any other. It will guide him in his practice, prevent him falling into rut methods, help him to bridge gaps in his work otherwise impossible.

The theoretical knowledge required of a loading officer is of the simplest character, but it should include the following: What is meant by (1) displacement; (2) center of buoyancy; (3) center of gravity; (4) a mechanical couple. All men who have to do with stowage operations, from practical observation, know that a ship sinks in the water when cargo is shipped, and rises out of it when cargo is discharged. They know this, but not all of them grasp the fact that the weight of water in the layer through which the ship sinks or rises and that of the cargo shipped or discharged is the same. If they did so the deadweight scale would have a new meaning to them.

Again, the center of buoyancy is commonly described as the center of the volume of displacement. Its importance lies in the fact that the line of the aggregate upward pressure of the water passes through it; thus whatever be the position of a vessel in the water, the direction of the upward pressure is always easily determinable.

The center of gravity is the center of the entire floating weight, *i. e.*, of the ship and cargo. It is the point through which the total weight acts however the vessel be inclined. In regard to the term "mechanical couple," it may be said that any two equal and opposite forces acting in parallel lines at a certain distance apart, constitute a mechanical couple. In the case of a floating ship the two equal forces are the downward weight and the upward pressure. These forces are always in operation. If a ship is at rest it simply means that the arm of the couple is zero; that is, the forces act in the same vertical line. Fig. 1 illustrates this condition, *B* is the center of buoyancy, *G* the center of gravity; the lines of the forces are coincident with the middle line of the ship. Now let the ship be heeled from the upright. Fig. 2 shows the new condition of things. The under-water form alters in shape; the center of buoyancy is now at B_1; the center of gravity, however, does not change, no weight having been moved on board. Thus, in this case, the two equal and opposite forces act with an arm between them, a mechanical couple being in operation on the vessel. Let *W* be either of the equal forces, and *G Z* the

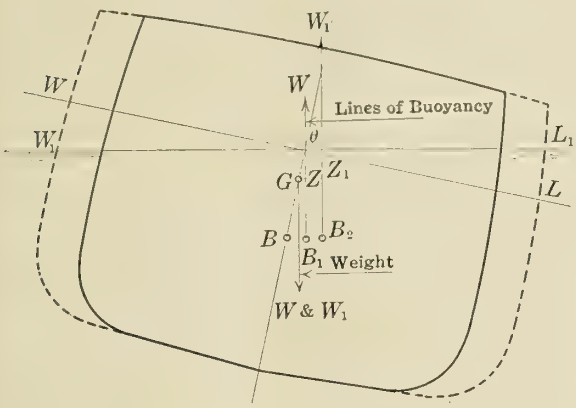


FIG. 3

distance between them (Fig. 2), then the product $W \times G Z$ is the moment of the couple and measures its power to turn the vessel. In books on mechanics innumerable examples of mechanical couples are instanced. The training of a stevedore, then, should include a knowledge of mechanics sufficient to make the preceding points perfectly clear. Anything beyond this, however, is non-essential.

Quite as important as the foregoing is the need of training the beginner to think, so to speak, in drawings. If his attention were directed to a drawing such as Fig. 2, and he were told it was a transverse section of a ship, it should express a perfectly clear idea to him. In his mind's eye he should see the body of the vessel tapering in each direction beyond the section. If he could do this he would see the form of the wedge $L\ S\ L_1$; for instance, as something like a slice of a much elongated orange. He would also be able to predict the effect of change of form on the positions of *B* and *G*. He would know that fining the lower form would raise *B* and move slightly *G*, and very soon he would grasp the effect of this on the stability. He would also be able to appreciate the influence of breadth. It is commonly understood that broadening a vessel increases her stability, but the officer trained to think in drawings could explain this to himself and others.

He could make a sketch like Fig. 3, for instance, and show the precise effect on stability of increasing a vessel in breadth by a given amount. For simplicity, he would assume *B* and *G* to be at the same height in both cases, the change in the stability being then entirely due to the increase in breadth. At any inclination, Θ, say, the center of buoyancy in the original vessel moves out to B_1, and in the broadened one to B_2. The resultant upward pressure passes through these points. The downward forces pass through the same point *G* in both cases. The righting arm increases from *G Z* in the original vessel to $G\ Z_1$ in the broadened one. In the latter case, too, there is an increase of displacement; thus increase of breadth augments both factors of the stability moment, namely, the weight and the leverage. All this is obvious from Fig. 3. The importance to the loading officer of being able to express himself in a drawing can, therefore, be hardly overestimated.

In the writer's opinion a method of instruction likely to be

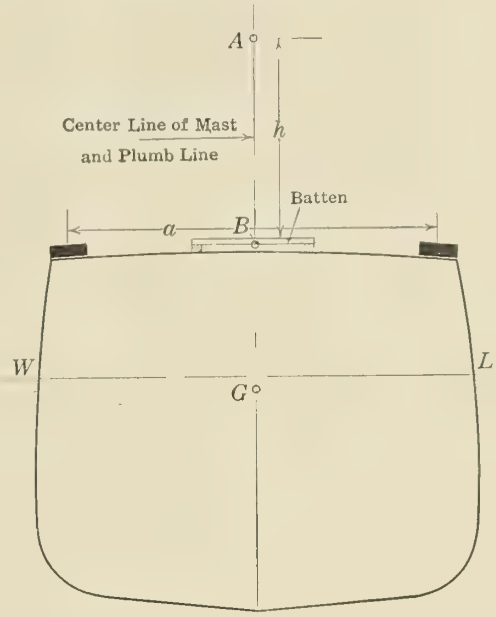


FIG. 4

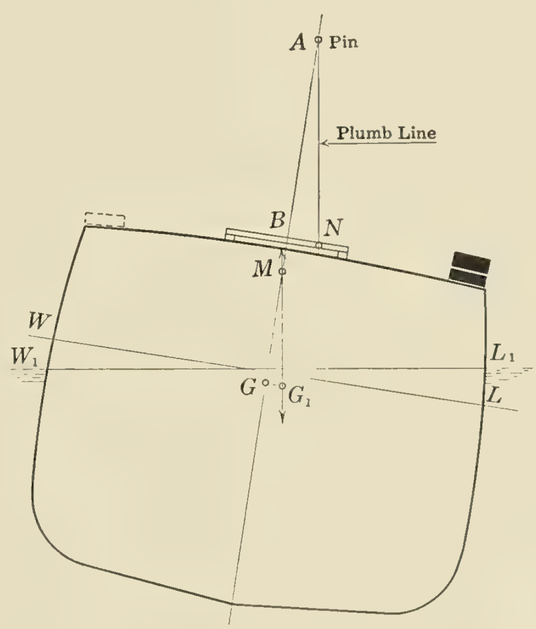


FIG. 5

fruitful of results is one involving the use of models. A man to whom a drawing is a mystery, and a demonstration in algebraical symbols about as intelligible as Greek, may readily grasp the meaning of a practical experiment. He cannot fail to note a concrete result, although unable to follow the steps that lead up to it.

Thus the effect on stability of increasing the breadth may be demonstrated as follows: Place two models of the required proportion, of the same general contour of lines, and loaded to the same draft, in a tank of water. In each let there be a vertical mast, having a string, or fine wire, attached at the same height above the deck, to provide a means of forcibly heeling the models. There should be an arrangement for measuring the force of the pull in each case. When the models have come to rest in the upright position, let a gradually-increasing pull be exerted upon each until they reach the same angle of heel, say θ. It will be found that P_2, the force required to hold the broad model at the inclination, is greater than P_1, the force necessary for the narrow model. Since the upsetting levers are the same the forces are measures of the righting moments in operation. Thus the effect of increasing the breadth is, as previously shown, to augment the stability.

To show the importance of exercising care in stowage, consider the following experiment: Hollow out the model it is intended to use so as to provide a space to correspond to the hold of an actual vessel. Into this space stow blocks of material of various densities. In the first instance, let the heaviest pieces be placed lowest in position. Now heel the model to some angle as in the previous experiment, and ascertain the force of the pull. Next, remove the blocks and replace them with the lightest lowermost. Heel the vessel to the same angle as before and measure the force. The pull in the second case will be found less than in the first, showing a falling off in the righting moment, a state of things entirely due to the rise in position of the center of gravity.

Lastly, fill up the cargo space with very light homogeneous material, and to bring the model to the required draft pile the cargo on the deck, the case corresponding to that of a vessel carrying a deck load. Suppose the model forcibly held in the upright position during the loading, and, on release, that it heels over and comes to rest at some moderate angle from the upright. This shows the model, as loaded, to be initially unstable. Now exert a pull on the mast string and incline the model still further, holding it at rest at the increased angle. That a certain force is necessary to do this shows the existence of a positive stability moment in this position. Thus a vessel, initially unstable, may not be completely so. In an actual vessel with such characteristics, if a portion of the cargo were removed, and a compartment of the ballast tank run up, she would regain an upright position and might be navigated with confidence. The filling of the tank, however, would have to be done with great care and in perfectly still water, as loose water causes a reduction in stability.

If, instead of coming to rest at a moderate angle, the model on release after loading turned turtle, her condition would be one of complete instability. A vessel of the type of such a model would, of course, be unsuitable for deck loads.

We have indicated how important it is to know the position of the center of gravity when considering a vessel's stability. The use of a model affords a specially convenient means of explaining the experimental method of determining the point. The necessary calculations are simple, but two principles are involved which must be understood. One is that if a single weight in a system of weights be moved through a certain distance, the center of gravity of the system will move in a parallel line, in the same direction, through a corresponding distance, which bears the same ratio to the first distance that the single weight does to the weight of the system. The other principle is that the corresponding sides of similar triangles are in proportion. The method of the experiment may now be explained: Fig. 4 shows in section a model floating freely and at rest. From a pin on the mast a plumb bob is suspended, as shown. On the deck a horizontal batten is fitted. On each side of the deck, as far out as possible, weights of equal amounts are placed. Let the distance between the centers of the weights be a and the length of the plumb bob h.

To begin with, the position of the plumb line, when the model is upright, is marked on the batten. Then the weight on one side is moved across the deck and placed on top of that on the other side, the model heeling in consequence and the plumb line taking up the position $A\ N$. Now suppose G to be the center of gravity of the model before the movement of the weight. After the movement it is in the position G_1, and a vertical through this point intersects the middle line at M. The model is again at rest; Fig. 5 shows the new position. Clearly, the triangles $A\ B\ N$ and $G\ M\ G_1$ are similar, therefore by one of the principles mentioned

$$\frac{G\,M}{G\,G_1} = \frac{A\,B}{B\,N},$$

and

$$G\,M = G\,G_1 \times \frac{h}{B\,N} \qquad (1)$$

substituting for $A\ B$ its given value h.

If each of the heeling weights be w, and the total displacement of the model W_1, by the other principle

$$\frac{G\,G_1}{a} = \frac{w}{W},$$

or

$$G\,G_1 = \frac{w.\,a}{W}.$$

Substituting in (1)

$$G\,M = \frac{w.\,a}{W} \times \frac{h}{B\,N} \qquad (2)$$

All the terms on the right-hand side of equation (2) are known, therefore $G\ M$ is known. Now M is called the transverse metacenter. It is approximately fixed in position for all small inclinations from the upright. A diagram of metacenter is made from the drawings of the model from which the position of M corresponding to any draft is easily obtained. Since the height of M is therefore known it is only necessary to measure down the distance $G\ M$, as found above, to determine the position of G.

Take an example: A model 17 feet long has a displacement of 1,700 pounds; calculate the value of $G\ M$, given that a weight of 5 pounds moved 24 inches across the deck, deflects a 12-inch plumb line .56 inch. Substituting the values given in equation (2) we have

$$G\ M = \frac{5 \times 24 \times 12}{1{,}700 \times .56} = 1.51 \text{ inches.}$$

To get the height of the center of gravity above the base line, this value of $G\ M$ is deducted from the height of the metacenter as given in the metacenter diagram.

In performing this experiment with an actual ship the process is practically the same as the foregoing, the units, however, being a foot and a ton. Space will not permit us to proceed further, but we have by no means exhausted the possible applications of model experiments as means of conveying instruction on this important subject. The effect of a shift of cargo, of bilging a hold compartment, of filling double-bottom tanks, etc., may be studied in this way, and much more convincingly than by abstract investigation of a ship's drawings. In any adequate scheme of instruction, model experiments should therefore play a prominent part.

Shipbuilding in Japan.—According to a report from the British Consul-General in Yokohama there are 230 shipbuilding yards in Japan. During the last year these yards turned out 77 steamers of 24,479 tons and 147 sailing vessels of 11,097 tons. This is a decrease of 58 sailing vessels from 1910 but an increase of 19 steamers, the tonnage of the latter, however, decreasing 38,996. All of Japan's leading steamship lines are preparing to build additional steamers for foreign service, mostly medium-size freight and passenger vessels. Japan's total shipping now includes 2,545 steamers of 1,233,909 gross tons, 6,392 sailing vessels of 414,720 gross tons, and in addition a large number of junks.—*Engineering.*

The Handicap of the Technical Graduate

BY PROF. H. A. EVERETT*

One occasionally hears from those engaged in the actual building of ships complaints of the incompetency of the technical graduate, and it is a very serious charge. In many cases the complaints come from careful and thoughtful managers, and these need our most careful attention. To illustrate by a specific instance, a gentleman recently stated that the technical graduates which he had received were no better than the apprentices trained in his yard beside whom the graduates had been placed at work, that they were impatient for advancement, and that in many cases had not had sufficient practical work to make them of much value at the bench or in the yard.

Narrowly judged, this is true, and must always be true, but in its broader sense it is entirely false, for the aim of the technical college is not to turn out apprentices or even mechanics. The first short interval of time that the technical graduate is employed by any manufacturing company is by no means a fair test of his value, yet it is in this period that the major part of the dissatisfaction is felt on both sides, employers and employees.

The true graduate of the technical school is not a practical man when he graduates, but has the training to learn rapidly to become one, and then will be able to do what the man of practical training only can probably never do. He has been trained along the technical lines of his profession and has been given such practical work as can be crowded into his curriculum without sacrificing the important technical elements, and is a man who goes out into the world upon graduation equipped with a technical training and a mental development which is intended to permit him to acquire the practical work of his profession and the details of the business of his employer in a quick and accurate manner. He is *not* and *should not be supposed to be the equal* in practical work of the apprentice who has spent a time equivalent to the graduate's *four years' technical training* in the *actual practice of his trade.*

A young man comes to a technical college and devotes four years of his life to the work here. In that four years it is his object to get the most out of it that he can, and it is the object of the school to give him the most that can be given in the time available. The question of choice of courses, or rather the items which shall be taught, is a broad one, and there is a constant pressure from outside to increase the proportion of practical training. To a certain extent this is desirable, but only to a very limited extent, for while the student can readily acquire practical training upon graduation, it is extremely difficult for the practical man to pick up the technical work. Consider a moment the result of largely increasing the details of construction taught and the practical work given in the courses. The time available for work is in practically all institutions almost entirely utilized at present, and it would be necessary to drop some of the technical subjects now taught. What should be dropped is a very interesting question, and if any two competent practising naval architects could agree on what items should be dropped it would be most surprising. Our experience has been that when pressed for specific courses which should be dropped, the answers have been as varied as the number of individuals asked, and the reason is not difficult to see, for while each may honestly quote some line or sort of work which he has not had occasion to use in *his personal experience*, the experiences vary as much as the individuals. Only very recently a gentleman eminent in his line, the manufacturer of a certain form of ship equipment, told me that since graduation he had had no occasion to use his higher mathematics. It so happened that this man's firm had only the previous year applied to us for a man, and had specifically required that the man be competent to handle with facility higher mathematical calculations. I afterwards found that calculus and spherical trigonometry were what had to be used, and *were* used in the design of the article which this firm was producing. On calling the complaining gentleman's attention to this he admitted that quite truly he had used his higher mathematics in the development of this article, but had forgotten it. Here is a case where a man technically trained used his training *without realizing it,* and used it where the non-technical man would have failed, and this occurs even oftener than most of us realize. The technically trained man has the training and the ability to use it to meet the *emergency,* and it is this meeting the *emergency* which makes a man valuable, not the satisfactory completion of the routine work. If the present curriculum were modified to include radically more practical work (at the expense of the technical training) it would be extremely difficult, after graduation, for the student to increase his technical knowledge to anything like the amount which he has with the technical training on its present plane.

This is a thing which seems to be entirely overlooked by a great many employers of labor, especially in the shipbuilding line. They want a man from the technical college, they invariably want one of the "best men," they expect that man to be trained in the practical details of ship and engine construction, in the technical work, and still further to be trained in the details which are special to their own yard. If the man they obtain is not fully conversant with the details of the work upon which they have found immediate use for him, they are disappointed and give utterance to the complaint before stated. This is wrong and the fault does not lie with the technical school in any way. These men must, and have, sacrificed practical work to the technical, which means that the student on graduation must serve a certain length of time in a shipyard in order to make himself familiar with the details of the profession in which he is to engage. This is a thing which must be acknowledged by the employer and which should be made easy by him. Practically all employers agree that if a technical man has been out five or ten years he is a very valuable man, and they would rather have him than any practical man that they could pick up, and yet in many shipbuilding works they are not willing to make the sacrifice which is necessary for the first few years to hold the graduate in the profession.

Look at it from the young man's point of view. He has spent four years in a technical college, and has spent, we will say, from $2,000 to $3,000 (£974 to £1,460). If he goes into a shipyard and cannot then receive a living salary, regardless of his predilection for the work, he feels forced to secure work in other lines which *will* offer him a higher remuneration, so that at the end of the two or three years the result has been that the profession of naval architecture has lost a good man merely because shipyards were not willing to pay a living wage for the first few years. I think that this can be most forcefully brought out by a diagram. If we trace two curves which we might call curves of advancement, showing salaries as ordinates and time as abscissæ, the curve for the non-technical man would look something like a curve *A* in the diagram—that is, his rate of advancement would be considerably higher at the start than the technical man's up

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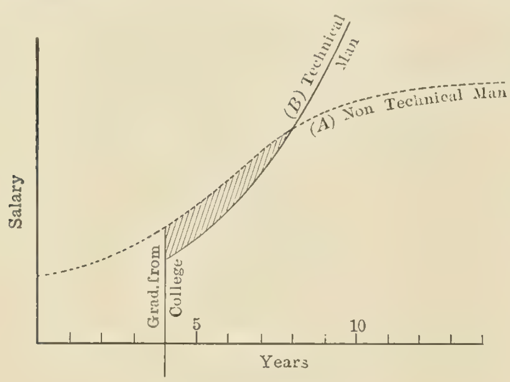
to perhaps six or seven years, but from here on his advancement is apt to be very slow. Considering the curve *B* of the technical graduate, the rate of advancement for the time through college is nil, he begins his work at a very low salary in many cases, and for a few years subsequent to graduation his rate of advancement is not much faster than the corresponding rate for the non-technical man, but at the end of perhaps five or six years after graduation his rate of advance is considerably faster than the other man's.

Now it is the section between the two curves that is indicated by the shaded area which causes the present trouble. If the technical graduate can struggle long enough to get by the shaded portion of this curve to a place where his advancement is fairly proportionate to his capacity, he seldom quits the profession. On the other hand, if he gets discouraged previous to reaching this place, he enters some other line of work which offers more remuneration immediately.

It is of little value to make statements with reference to existing conditions which may not be as we wish them unless specific suggestions for their betterment accompany them, and



CURVES OF ADVANCEMENT

it is this that I have in mind. There are things which can be done by the technical school, and there are also things which can be done by the shipbuilder, all of which will tend to minimize the troublesome shaded area.

The technical college can increase the amount of practical work accorded to its students if the shipyards will *co-operate* in permitting men to obtain practical experience in summer, and in making suggestions to the faculty as to lines along which practical details are found to be needed. Some yards dislike to take men for short periods during the summer, claiming that they are merely a nuisance, which, to my mind, is largely a reflection upon the *management* of the men and the tasks allotted to them. Summer work, in conjunction with the regular course of the school, has worked out to advantage in many of the foreign colleges and is a fixed part of the curriculum of the Royal Naval College at Greenwich, the Ecole d'Application du Genie Maritime at Paris, Technological High School at Berlin, and in the Imperial University at Tokio, Japan, in which latter place the work done by the students is inspected by members of the faculty and a mark is given for the summer work. Furthermore, the technical school can counsel its graduates to have *patience* while acquiring the practical work.

On the other side, the shipyards can do much if they will be willing to accept technical graduates on some sort of a thoroughly understood basis whereby the men are started at a wage which is a living salary, put through whatever practical work it is desired to have them undertake, and at the end of a certain period of probation put them on the yard's permanent force at a reasonable salary, or discharge them. Some shipyard managers think this is a radical thing. It does not seem so, and I can cite many instances where it has been actually done in manufacturing organizations employing technical graduates, and has reacted to the tremendous advantage of the concern.

One concern which I have in mind has a practical understanding with a large technical school, whereby one or two men are furnished to this company each year. These men are accepted by the company on a three-year understanding; payment for the first year is about $15 (£3 2s. 6d.) per week, with an advance in the second and third years, which is dependent largely upon the ability of the individual. The first year the company may, in some cases, lose money on the man whom it employs, the second year it surely comes out even, and the third year there is a financial gain to the company. Then the man is either retained in a position of some responsibility or discharged. The result is that a man knows on going there that there is a long period of probation, in the second place he is able to live during this period of probation, and in the third place he is a man trained in the peculiarities and details of the business which is to follow at the time when the business wants him.

If such an arrangement as this operates to the advantage of the mechanical engineering profession, I can see not the slightest reason why it should not operate to the advantage of the naval architectural profession. Furthermore, this same sort of thing has operated to advantage in a concern which is doing a large business along what may be termed non-technical lines. Unless some such arrangement is brought about the result will be in the future, as it has been in the past, a drifting of the technical man, trained in the naval architectural field, into mechanical or operating lines, with its diminution of the corps of highly trained and able young men which should be available for this work.

Annual Report of the Chief of the Bureau of Construction and Repair

According to the annual report of Naval Constructor R. A. Watt, chief of the Bureau of Construction and Repair, U. S. N., the new shipbuilding work now in progress or authorized at navy yards includes the construction of the battleship *New York* at the navy yard, New York; the construction of the collier *Jupiter* at the Mare Island yard, and the construction of the river gunboats *Monocacy* and *Palos* at the Mare Island navy yard. These two yards are the only ones fully equipped for the construction of large vessels, and it is apparent that they will be busily employed for several years to come with shipbuilding work in addition to the ship repair work which is regularly assigned to them.

The three battleships *Texas, Nevada* and *Oklahoma,* at present under contract, are building under the eight-hour law. The average price per ton of normal displacement of the three vessels in questions is $215.26 (£ ???); the average price of the preceding battleships built by contract when the hours of labor were unrestricted was $177.25 (£???) per ton of normal displacement for the three preceding, and $189.99 (£???) per ton for the five preceding vessels.

The annual report of the Chief Constructor two years ago compared the rapidity of battleship construction in this and foreign countries and demonstrated by tables that the rapidity of construction in the United States is greater than the average rate of construction in the principal foreign shipbuilding countries. Notwithstanding the recent marked increase in size of vessels, the time required for construction remains practically unchanged, and the rapidity of construction in the United States, both for battleships and destroyers recently completed without restriction as to hours of labor, continues greater than the average rate of construction in the principal foreign shipbuilding countries. The effect of the eight-hour law upon the rapidity of construction is as yet indeterminate.

The additions to the effective force of the navy by completion of vessels building under contract and at navy yards are as follows: Battleships, *Arkansas, Florida, Utah, Wyoming;* torpedo boat destroyers, *Mayrant, Walke, Patterson, Jouett, Fanning, Jenkins, Beale, Jarvis;* submarine torpedo boats, *E*-1, *E*-2, *F*-1, *F*-2, *F*-3, *G*-1; colliers, *Orion, Neptune;* tugs, *Ontario, Sonoma.*

Westinghouse Telpherage System for Handling Freight at Steamship Terminals

The telphers manufactured by the Westinghouse Electric & Manufacturing Company, East Pittsburg, Pa., present a practical means for handling miscellaneous packages, or what is known as less than carload lot freight, in railway freight terminals and transfer stations. These machines hoist, convey and lower. They can be arranged to serve every point in any given space, and can tier packages to a much greater height than is possible by hand. Freight can be transferred by them from one point to another without rehandling and with much greater speed and economy than can be done by ordinary cranes, motor trucks or hand trucks.

The telpher train runs on an elevated single-rail track, and consists of a motor-driven tractor with one, two or three trailers. Each trailer is equipped with a motor-operated hoist. The tractor motor and trailer-hoist motors are controlled by an operator stationed in the cab of the tractor.

In operation the articles to be transported are attached to the trailer hoists, or are loaded on flatboards or trucks which are attached to the hoists, as shown in the illustration. The load is then raised and conveyed to the desired point. A number of extra flatboards or trucks are used, so that they can be loaded and unloaded without delaying the telpher.

The telpher track can be arranged in a number of different ways. Where goods are to be merely transported from one point to another, as from a freight station to a warehouse, a single straight track is all that is necessary. If the telpher is to load cars in a freight terminal, a loop is run around the building, and transverse tracks, reached from the main loops by switches, are run over each platform. Where it is desired to serve every point of a given area, as in a dock or warehouse, the track consists of a loop around the building and a movable transverse track, on to which the telpher can be run over gliding switches.

A Westinghouse telpher train can carry many times the load that can be handled by a hand truck and can move six times as rapidly. There is, moreover, little or no interference between telpher trains in a properly directed installation, whereas a great deal of time is often lost with trucking on account of congestion in the aisles. The telpher train does not have to wait for loading and unloading—it deposits an empty flatboard and picks up a full one (or *vice versa*). It is obvious therefore that freight handling by telpherage must be considerably more rapid than by trucking.

The increase in the capacity of a station is effected in several ways with a telpher. In the first place the greater rapidity of the telpher tends to reduce the amount of goods stored on the receiving platforms. Secondly, where packages are tiered by hand the tiers cannot be economically made higher than 5 or 6 feet, whereas with the telpher system the height of the tiers is limited only by the clearance required by the telpher in passing over them, and in places where the telpher does not pass over the tiers they can be raised 5 or 6 feet higher. Two or three times more freight can therefore be placed on a given floor space.

The economy of the telpher as compared with trucking is the natural result of its ability to handle large quantities of material so much more rapidly. In one test case fifteen men with telphers loaded 2,000 tons of freight in the time required for 110 men to load the same quantity by hand trucking. In general, when a Westinghouse telpherage system supersedes hand trucking the saving in the cost of handling freight, after deducting interest on the necessary investment, is from 25 to 40 percent.

With a telpherage system practically all lifting is done by the hoists. All heavy articles are hoisted separately and light articles easily handled are stacked on flatboards. Raising and lowering by means of the hoists is obviously less liable to cause injury or breakage than trucking.

A feature of the Westinghouse telpher system is the use of a separate tractor with several trailers instead of a combined tractor and carrier.

This arrangement is more economical for several reasons. There is less deadweight in proportion to the carrying capacity, and hence less power is required. When not required one or two of the trailers can be disconnected, which further reduces the deadweight.

The use of separate trailers also increases the speed and ease with which freight can be handled. In handling less than carload lots the various packages constituting a consignment must be kept together. Since the average consignment weighs 750 pounds, a full train can carry three consignments on separate flatboards. Each consignment can be loaded on a flatboard, weighed, conveyed to the proper car, checked, and loaded with minimum loss of the time. When consignments consist of packages of different classifications the use of separate flatboards is even more desirable. One package after another is loaded on the flatboard and weighed, and the whole consignment is kept together.

A WESTINGHOUSE TELPHER TRAIN

In fact, where the tractor and carrier are a single unit it is found to be uneconomical to carry more than one consignment per trip, because of the trouble that arises from mixing consignments and the delay to the telpher occasioned by the partial unloading of the flatboards. The Westinghouse telpher train can, therefore, make three trips while the other kind is making one, which permits the work to be done with fewer telpher trains, less men, more speed, and much less congestion at the switches and loading platforms.

The frame of the tractor is a single steel casting; the wheels are double flanged. The motor drives the tractor through a silent chain and gears. A brake is applied to both wheels by turning a hand-wheel in the cab.

The cab is built of structural steel, and is so arranged that the telpher operator has an uninterrupted view of the track and the trailers. Drum controllers are mounted in the cab, one to control the tractor motor and the others to control the hoists.

The trailer trucks are similar to the tractor trucks. The suspension beams are pinned at the truck, and the hoist yoke is swiveled to the beams. Hence the load on the hoist is free to swing in any direction without tilting the truck.

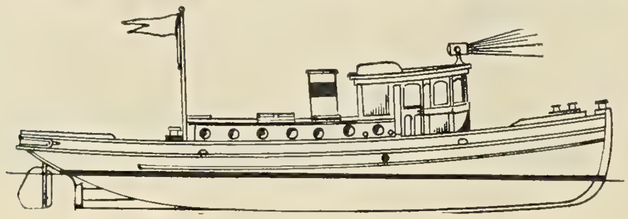
The hoists are operated by motors, each of which has a normal capacity of 2 tons, a maximum full-load hoisting speed of 60 feet per minute, and is provided with sufficient cable to hoist 50 feet. Electro-dynamic braking is used for lowering. Each motor has a solenoid-operated brake, which holds the load automatically when the power is cut off. A limit switch prevents over-winding by opening the circuit and applying the brake when the hoist is raised to a predetermined point; the hoist can, however, be lowered from this point by reversing the controller.

Standard Westinghouse, 230-volt direct-current crane motors are used for both tractor and hoist units. Current is collected from single trolley with bonded trail return or from two trolleys on non-grounded circuit.

An Unusual Motor Tug Built to Do the Work of Two Steel Steam Tugs

The work which the *Natilie*, owned by the Breakwater Company, of Philadelphia, is called upon to do is probably the hardest that has ever been given to a motor boat. This is in connection with the building of a jetty at Cape May, N. J. The *Natilie* runs from Cape May to near the breakwater and picks up 150-foot barges laden with stone and tows them through the breakers and into shallow water, where they can be dumped. While doing this work the boat is often driven ashore and pounded upon the hard sand bottom. This is what she was specifically designed for, and after several months she has not shown the slightest strain. The two heavily built steam tugs used hitherto could not stand the strain of this pounding upon the beaches.

The *Natilie* is 65 feet over all, with 18 feet beam. Her least depth of hold is 6 feet 4 inches and her normal draft is



THE MOTOR TUG THAT SUPPLANTED STEAM POWER

3 feet 6 inches. She can be made to draw 12 inches more by means of water ballast. Her freeboard is 6 feet 6 inches forward and 5 feet aft.

Her framing is double sawed oak timbers 8½ inches by 8 inches, spaced 22 inches on centers. Her deck beams are each 8 inches by 8 inches and 24 inches on centers. The main keel is a solid stick of oak 10 inches by 12 inches and the main keelsom is 12 inches by 12 inches. She has four sister keelsoms each 8 inches by 8 inches, and bilge stringers each 6 inches by 10 inches. Her sheer strake is 6 inches by 10 inches.

It would seem that this framing would ordinarily be sufficiently heavy for a 125-foot steam tug, but this is not all the extra weight timber that enters into the *Natilie's* construction. She is planked with selected oak 2½ inches thick and sheathed with 3-inch yellow pine, bolted through. Her deck is of oak and pine, laid in strips 3 inches square. The oak skeg is built up tapering from 8 inches at the bottom to 14 inches at the shaft line. All fastenings are of galvanized iron, many of them being bolts set up with nuts, and every effort was made to fasten everything as securely as possible, weight of metal being disregarded to secure the maximum strength.

The superstructure is of oak and pine. The main house is but 3 feet above the deck. The floor of the pilot house is 12 inches above the deck and the height of the roof is 8 feet. Although the superstructure was kept as low as possible, head room was not sacrificed. In the pilot house there is 6 feet 6 inches and in the main cabin 7 feet 6 inches. The cabin is well arranged for the comfort of the crew, there being three staterooms, a combination galley and mess room, a toilet room and two large storerooms for hawsers, etc. There are also transoms in the pilot house that may be used as berths.

There are two watertight compartments forward and two aft, one in each end being arranged that they may be used for the storage of fresh water for ballast or to supply the steam derrick barges and other vessels of the company. The tanks have a combined capacity of 15,000 gallons.

Probably no motor boat has such a complete and powerful engine equipment as the *Natilie,* as she has all the appurtenances of a modern wrecking tug combined with the equipment of a fireboat. Her main engine is a 125-horsepower air-starting and reversing Eastern Standard engine. This engine starts, stops and reverses without the means of a reverse gear. Its operation is as simple as that of a steam engine, being done by the shifting of a lever. The compressed air is fed into the cylinders in the same manner as the gas cycle of the engine, so that one does not interfere with the other. A compressed air pump built on the engine supplies a large tank. This pump has an automatic "cut-off" device, so that when the air pressure reaches its maximum it stops pumping. When the pressure drops below normal it automatically "cuts in" and starts pumping.

The *Natilie* is also equipped with an 8-horsepower, 4½-kilowatt Standard auxiliary engine direct connected to a 110-volt generator for operating deck and running lights and a 9-inch searchlight and two electric motors. The electric outfit has a telltale system, so that if one of the running lights goes out a light flashes in the pilot house and a buzzer starts.

One of these motors operates a 4-inch wrecking pump that is equipped with 25 feet of hose, so that the tug may be placed alongside another vessel and pump her out. This pump can also operate four lines of 2-inch fire hose, taking the supply from overboard or from the fresh water tanks. Likewise the pump can be used for transferring the fresh water from the tanks to another vessel or for shifting the tank water from one tank to the other. The auxiliary engine also has an air pump which can be used as a water pump, thus giving the boat two complete pumping outfits.

The second motor is on the after deck and operates a gypsy windlass, which is another novel feature for a tug of this size. This was installed for handling the 8-inch hawsers necessary in the work the *Natilie* does. There is an unusually large iron double bitt and windlass on the forward deck and large iron bitts on each side.

For ground tackle the boat is equipped with two patent anchors, one weighing 300 pounds with 200 fathoms of 4½-inch hawser, and the other 500 pounds with 200 fathoms of ¾-inch stud-link chain. The general outfit is practically the same as that on an ocean-going steam tug.

The *Natilie* was designed by Captain I. A. Watrous, master mechanic of the Breakwater Company. She was built by M. M. Davis & Son, of Solomon's, Maryland. The Breakwater Company has just bought a 300-horsepower Standard engine of the same type as the engine in the *Natilie,* which is to be placed in service in the Hawaiian Islands.

A Typical Pier Fire.—A two-story pier in Philadelphia, Pa., owned by the Baltimore & Ohio Railroad, and used by the Hamburg-American and Italian steamship lines, was completely destroyed by fire early in October. The inaccessible location of the pier and the lack of automatic fire protection were responsible for this disaster. Other cases where fires have started in a similar manner on steamship piers are not infrequent, but where the pier is equipped with an automatic sprinkler system it has been found invariably that the fire was promptly extinguished before it had gained sufficient headway to cause more than trifling damage. Such a disaster is a strong argument for the immediate adoption of a reliable automatic sprinkler system on all steamship piers as a protection against fire.

Towboat Narragansett, General Utility Boat

The towboat *Narragansett,* recently completed by the Atlantic Works, East Boston, Mass., was built for the Staples Transportation Company, of Fall River, Mass., as a "general utility" boat. She is intended primarily as a harbor and bay towboat, but has ample power, coal and water capacity to engage in coastwise towing; in addition, she is equipped as a fire, wrecking and water boat, and the hull was designed and constructed with the object in view of making her very efficient as an ice breaker.

The boat is 100 feet long, 24 feet 6 inches beam, and 12 feet 9 inches deep, and, with bunkers and tanks filled, draws 11 feet 6 inches aft and 9 feet forward. The frame and planking are of white oak, the planking being 3 inches thick, the keelsons, ceiling and beams are of yellow pine, and the deck of Oregon fir. The hull is salted from a point 2 feet below the waterline to the deck. She has a Hyde Windlass Company combination hand and steam steering gear, the steering engine being placed on the main deck in a recess at the after end of the engine room, with a small steering wheel fitted on the top of the deck house at the after end for convenience in handling the boat when docking vessels, etc. A Hyde steam capstan for handling hawsers is fitted at the stern.

HARBOR TUG EQUIPPED AS A FIRE, WRECKING AND WATER BOAT

The deck house has the usual galley and messroom at the forward end, with two staterooms about amidships for the engineers, and a spare stateroom aft, the captain's stateroom being directly aft of the pilot house and the crew's quarters in the forecastle.

As it is necessary at times to send this boat into shallow harbors, the hull was so designed and balanced that by pumping water from the after tanks to the forward tanks, and by admitting sea water to the forepeak, the boat can be brought to a draft of 10 feet or less forward and aft, an ejector being fitted to discharge the water from the forepeak overboard when the boat is to be returned to her normal trim.

The machinery consists of a fore-and-aft compound, surface-condensing engine having cylinders 14 inches and 32 inches diameter by 24 inches stroke, and develops 450 horsepower in service conditions. The engine is of the open front type with cast iron back columns and forged steel front columns, the condenser being independent of the engine frame. The high-pressure cylinder has a piston valve, and the low-pressure cylinder has a double-ported slide valve with counterbalance cylinder. The engine has steam reverse gear, and an adjustable cut-off consisting of ratchet teeth on the end of the connecting rod of the reversing cylinder, with a pawl that can be engaged with the ratchet teeth, thereby shortening the travel of the valves. When the engine is reversed the pawl falls out by its own weight and the valve gear then goes to the full travel, ahead as well as astern. The regular throttle and reverse levers are fitted in the lower engine room, and another set of levers is also fitted in the upper engine room, so that when docking vessels and doing similar work the engineer can handle the engine from the upper grating.

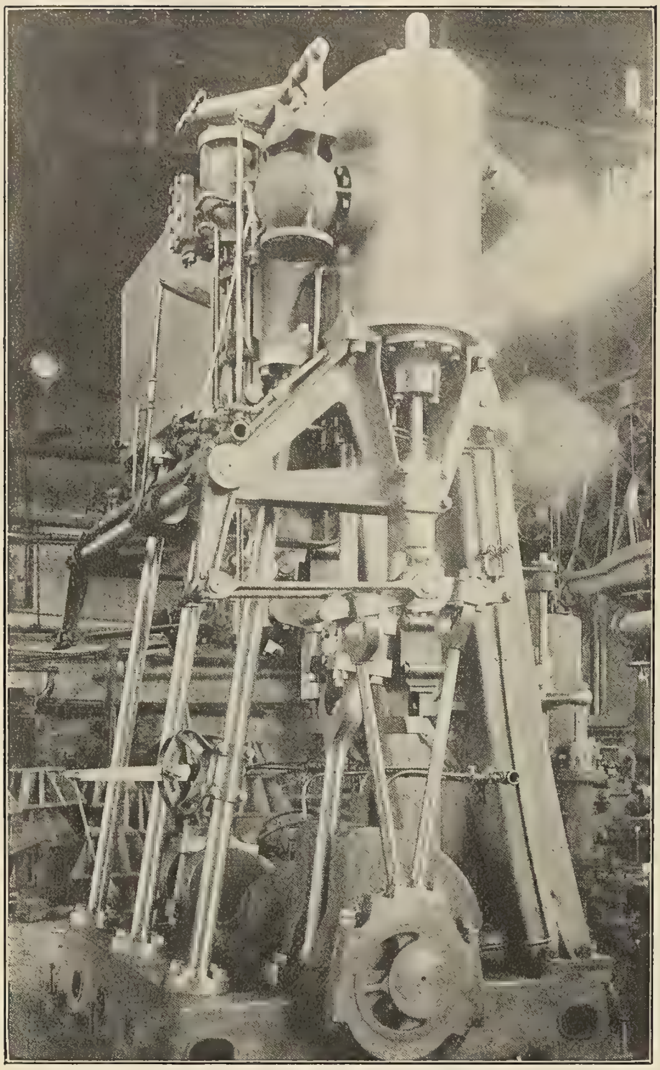
The boiler is of the Scotch type, 12 feet diameter by 11 feet long, having three removable Morison suspension furnaces, and has 60 square feet of grate surface and 1,600 square feet of heating surface, the working pressure being 165 pounds per square inch.

The circulating pump, air pump, boiler feed pump and bilge pump are connected to the main engine, and are worked by a beam from the low-pressure crosshead. The connected feed pump is of smaller capacity than would normally be fitted to an engine of this size, in order to prevent the feed pump drawing all the water from the hot well when the engine is running at slow speed, and a small independent steam feed pump is fitted, this pump being regulated by a float in the filter box so as to handle the balance of the feed water and maintain a suitable level of water in the hot well.

The boat is provided with an efficient fire pump having four hose connections on the side of the house, this pump also having a deck suction so that it can be used as wrecking pump. A closed feed water heater is fitted, the heater taking steam from the low-pressure receiver, and also the exhaust steam of the feed pump. The thrust is of the horseshoe type running in an oil bath.

The coal bunkers have a capacity of 50 tons, stowed in an athwartship bunker having a coaling trunk extending to the top of the deck house, and in side bunkers with the usual bunker deck plates. An ash ejector is fitted in the fireroom.

A small steam pump is also installed, which is used only for pumping fresh water, the suction being connected to the tanks, with a discharge on deck, so that the boat can be used when



MAIN ENGINE OF THE NARRAGANSETT

required as a water boat for filling the tanks of barges and other vessels.

The question of speed was not given special consideration in designing this boat, but on her trial trip, which was made at Boston, September 23, 1912, she made about 12 knots, which was very satisfactory to all concerned. The boat and engine are shown by accompanying photographs.

Triple-Screw Motor Ship Alkmaar

BY J. RENDELL WILSON

Recent developments of the marine Diesel engine have brought to light the fact that there are about thirty different motors of the semi-Diesel, or low compression heavy oil-consuming type, constructed by various firms on the Continent of Europe and in the British Isles. In America there is the Mietz & Weiss. The engines are of great interest, and deserve better attention than they have received in the past, as, like the Diesel, they use low grades of kerosene (paraffin) or residue oil as fuel—although not quite as heavy oils as the Diesel. With the latter the fuel is burned at constant pressure, whereas the semi-Diesel requires a hot bulb for the purpose of vaporizing and firing the oil. Both four-stroke and two-stroke cycle engines are on the market.

An interesting passenger vessel driven by three semi-Diesel engines has just been placed in service on the river Zaan, between Amsterdam and Alkmaar, by the Alkmaar Packet, Ltd. She has been built by the Nederlandsche Scheepsbouw Maatschappy, of Amsterdam, and is of the shallow draft class with three decks, and has a capacity for nearly 1,500 passengers. *Alkmaar,* as the vessel is named, is 134 feet 6 inches long over all, and 128 feet between perpendiculars, by 25½ feet extreme beam, 24 feet 5 inches waterline beam. The depth from keel to the upper deck is 33 feet 6 inches, while her draft is under 6 feet. It is interesting to note that a steam vessel of her dimensions to carry the same number of passengers would have a draft of about 8 feet, which in this case is impractical, as the river Zaan is not more than 7 feet deep.

Her accommodation arrangements are as follows:

Under the first deck the forepart is given over to the first class saloon, which is finished in old oak with Delftware cosy corners, toilet rooms, etc., while the second class is aft of this space. On the first deck the first class quarters are also forward and the second aft. Right forward on the second deck the steering apparatus has been installed, aft of this a first class saloon finished in Louis XV style and a second class saloon aft. The third and upper deck is well provided with seats for first and second class passengers. Several glass screens are placed to protect passengers against the wind. Altogether there is seating accommodation for some 1,000 people, but, of course, many more can be carried.

Special care has been given to the steering gear arrangements, as no steam is available, and a motor-driven gear was considered too complicated. The wheel is connected to the rudder by a shaft supported in ball-bearers working an eccentric gear wheel, which moves an oval quadrant, fixed at the rudderhead. This arrangement, very cleverly thought out, renders it quite possible for one man to turn the rudder hard over even when running at full speed.

Her machinery consists of three two-cylinder Kromhout engines, constructed by Messrs. D. Goedkoop, Jr., of Amsterdam, each developing 90 brake horsepower at 280 revolutions per minute on the two-stroke principle. They are of the single-acting, non-reversing type, and each turns a 4-foot 1-inch diameter propeller through a reverse gear.

The system of operation is quite simple. On the down or explosion stroke, scavenging air is compressed in the crank case and is admitted to the cylinder through ports just before the completion of the stroke. On the upward stroke the air is compressed to about 200 pounds into a lamp-heated bulb, or special combustion chamber, and immediately before it reaches its highest point fuel is sprayed in through a valve from a small plunger pump, one for each cylinder, and combustion instantly occurs. The lamps are needed only for starting, as once the engine is well going the heat of the explosion maintains the bulb to a red heat.

In the engine room there also is a single-cylinder Kromhout engine driving a dynamo for electric lighting, and operating the bilge and general system pumps. Each main engine is equipped with a water-cooled silencer and the exhausts are led to a big silencer in the funnel. At the after end of the engine room is a platform where the reverse gear levers and engine controls are arranged, allowing the entire machinery to be maneuvered by one engineer. Starting is by compressed air, obtained from the explosions in the engine cylinders and stored in three large reservoirs.

The *Alkmaar's* official trials were run on October 5, and the following day she commenced her regular service, which probably constitutes a record for a vessel of her class. The voyage from Amsterdam to Alkmaar occupies between three and three and one-fourth hours, the average fuel consumption for this period being 28.5 gallons. During the trial trip an average speed of 10.6 knots was maintained, and with a full load of fuel on board with a displacement of slightly over 200 tons 11.6 knots were made.

Letters from Practical Marine Engineers

Incidents Relating to the Design, Care and Handling of Marine Engines, Boilers and Auxiliaries ; Breakdowns at Sea and Repairs

A Broken Condenser Baffle

When the writer first went to sea the chief engineer under whom he served insisted upon a rigid course of inspection of all parts of the plant at each end of the run. In a log book was listed all parts, and each part as inspected was ticked off, so that at the end of the run we would take up the work where we left off. And hence all details were constantly inspected with regularity, and while it involved a lot of work yet it amply repaid. It is not always the large parts that cause trouble; very frequently it is the very small detail that causes trouble.

On a new dredge working in Southern waters, there was trouble caused by a part that one would give the least attention to. This dredge was equipped with a triple-expansion engine, the condenser of which was separate and had independent air and circulation pumps. The circulator was, of course, placed in the lowest point of engine room, while the lower tubes of the condenser were on a line with the deck. On several occasions the circulator had slowed down, but the condenser did not get very warm, as it was discovered in time. One night as the second engineer was going on watch, he passed through the fire room, and noticed that the water-glass was showing three-quarters full. It was their practice to run with about 2 inches level in the glass. On reaching the engine room he noticed that water was running from the hot well overflow. He called the first assistant engineer's attention to this condition. The first assistant did not wait to be relieved, but was up in the messroom. When informed of the fact that something was wrong he turned to the second assistant, with the remark, "You know what to do, don't you?"

The second then reported to the chief, who stated that he would come below shortly. The second then notified the lever man that he intended to shut down and for him to clean his pipes. It is customary on suction dredges to wash out the pipes before shutting down the pumps, and as these pumps were direct-driven from the main engine, the whole plant would be shut down. The boilers were cooled and blown down to get the water down to the proper level and density. By the time the chief arrived all the tackle was up ready to handle the condenser bonnets and all the nuts removed. Upon removing the bonnets a couple of tubes were found to be leaking very badly, but a slight split in the tubes would hardly account for all the water. Well, the surprise was yet to come, for upon getting hold of the tubes only one-half of each was withdrawn. The tubes had been cut in two, and only two tubes were causing trouble. After the remaining halves were removed, and the tube plate holes plugged with ½-inch pipe plugs, the condenser was closed up and the engines were again started.

The following day the engines were again shut down to determine the cause, as this was a mystery that remained to be solved, because salt water could only get into the feed line or from the hot well through condenser leaks. The eduction pipe to the condenser was removed, and upon looking into the condenser the cause was discovered. The baffle plate, short at best, was broken in two, and hence every pulsation raised and lowered the halves, and they impinged upon two tubes only, and resulted in cutting them in two. The baffle plate was cracked as though it had been heated and plunged into cold water with resulting cracks, but the edges of the separated sections made a fine chisel. The boiler, feed heater and line were beautifully coated with salt and the bilges were filled. How it ever escaped the notice of the first assistant engineer's attention is a matter he will have to explain to others from whom he seeks employment.

A new baffle plate was sent from the shop with slight modifications. It was simply the regulation size baffle. They have been made, I believe, one size ever since surface condensers were used, and that size is as small as possible. No doubt it would hurt the feelings of designers to make them long and well supported, because they only baffle exhaust steam, and hence fill the bill. A baffle plate should be long and well supported, for the action of the exhaust steam causes constant flexure, and of course painting is not conducive to the life of the metal, and from this fact alone a baffle plate should be designed to withstand the strains set up. The new baffle plate was installed and work resumed. Of course, the machinery was in operation without one until it arrived. How long it will last it is hard to say. The loss of time, with its consequent financial loss, is not a small matter, for, as a rule, a dredging company figures on a dollar a minute loss for every minute the dredge is idle when working on a station, and it takes but little consideration to see that this is not overrated.

There was another very peculiar condition obtaining on this dredge. It appears when carrying the water about three-fourths glass full the engine worked dry steam, and when carried about 1 to 1½ inches in the glass the steam was very wet. There was a separator in the steam line, and when the engines were working wet steam a sample taken from the well of the separator was very dry, say about .97 dryness fraction, or, in other words, it did not contain over 3 percent moisture, and 0.97, I think, is placing it lower than it ever obtained. There is a reason for this, and I leave it to your readers to solve it.

It is only again a case of taking care of the first cost and permitting the builders to furnish anything and any arrangement that suits their ideas. The owners, however, are going to pay for this kind of work, as a naval architect's and marine engineer's time is too costly, but by the time these conditions are overcome his services would be a very small outlay compared to their bills, caused by inferior design and construction. The writer at some future time will have more to say on the arrangement of machinery, boilers, heaters, etc., of this type of non-propelling dredge. Charles S. Linch.

Patching a Boiler

The following is an account of a breakdown that occurred under trying conditions when I was chief engineer of a Greek steamer. I took on a contract to take the steamship *Spiridon* from Cardiff to Constantinople, the vessel having been purchased by a Greek company from a South Wales company. Two days after I signed the contract we had to put to sea without my being able to thoroughly examine the multitubular boiler, which had been out of commission for three years. We left Cardiff on the morning of October 14 and experienced terrific seas in the Bay of Biscay. My assistant and I were kept imprisoned for three days, and had our food lowered down the after ventilator by the cook, whose galley was within reaching distance.

After having been awake for the most part of the time I lay down on a locker exhausted, and then slumbered only to be awakened in a few minutes by a terrific report, which seemed to shiver the ship from stem to stern. The two firemen rushed up the ladder, and had to be brought below again by divers threats. My assistant, when he could find me in the midst of a scalding, seething steam, shouted that he thought the circumferential seam had "started" on the bottom of the boiler.

It did not take long to find out that something more serious than a seam had gone, for the water in the gage glass was dropping very rapidly. I ordered the fires to be drawn out—there was nothing else for it. We tried to keep the boiler full with the pumps, but that was useless.

As soon as the boiler emptied (it took seventeen minutes only) I crawled under the boiler and found near the circumferential seam at the front end a hole about 1 inch by 1½ inches and for a radius of about 2 inches the plate was very thin.

We looked around the engine room and found two pieces of plate ½-inch thick, 3 inches by 2½ inches. One piece we heated and "stepped" to fit into the joint of the seam on the inside, and the other simply curved to the sweep of the shell on the outside. Through the centers of these plates we drilled 1-inch holes. Two joints of asbestos cloth were cut and a 1-inch bolt passed through the plate on the inside and through the boiler shell and the outside plate, leaving the nut on the outside to facilitate screwing up tightly. To make doubly sure, we made some cement and covered up the inside plate about ½-inch thick and allowed it to set.

From the time the engines stopped to starting up again occupied exactly fourteen and one-half hours, and there were only three of us doing the work. Eight days after this we arrived in Turkey, having carried a full head of steam (135 pounds gage.) F. CHRISTIANSEN.

New York.

A Good Way to Block the Ports in a Steam Chest

On the way up the California coast a serious accident occurred which seemed wonderful in that no one was hurt. When making the necessary repairs it was also of interest to see how useful was the advice of a man who was supposed to know nothing of the trade. The motive power consisted of two triple expansion engines with four cylinders, the arrangement being forward low-pressure, high-pressure and intermediate-pressure, and after low-pressure. The engines were of the inverted type, with a combined power of 16,000 horsepower.

Everything was moving along nicely at 70 revolutions when something let go in the port high-pressure cylinder with three hard thumps and a lot of that sickly tearing and ripping of breaking material that sounds so terrible to those that have been unlucky enough to have been present at such accidents. But what the trouble was no one ever knew, as the steel piston was so bent and distorted that it was impossible to form an accurate idea of the cause, more than to guess that the follower bolts became crystallized and let go, as the bolts, follower and piston packing were all minced. The head was broken in thirteen pieces, the cylinder split down the side in four places for 30 inches, tearing away from the lugs that bolted to lugs on the forward low-pressure cylinder.

The throttle was closed at the first crash and the reversing gear thrown over, stopping the engine within eight or ten revolutions. It was phenomenal that none of the broken pieces from the head or cylinder fell on the man at the throttle, as the throttle was at the side and directly under the high-pressure cylinder, and the man stuck to the throttle until the engine was stopped.

The starboard engine was started up to 100 revolutions to take care of the steam. The port engine was secured, the jacking worm put in and the vessel kept on at nearly her standard speed without stopping until the next port was made. There the port high-pressure piston rod was fastened up with a strong back, the connecting rod removed, the valve gear disconnected and the valve placed to cover the ports, as neither the valve chest nor its steam connections had been damaged.

But so much steam got by the valve into the broken cylinder that the valve was removed and the ports were blocked with wedges and Portland cement and the engine put in use again. The wedges leaked, however, so that very little pressure, only 18 to 20 pounds, could be carried on the intermediate-pressure receiver and make it possible to live in the engine room.

When the next port was reached the wedges were removed and new ones were being put in with the hope of better luck. While this work was proceeding the coppersmith came up to see what the inside of a steam chest looked like, and after watching the process of putting in the wedges for a while and understanding what was wanted, made the remark that he could fix that in a very short time so that it would be tight, and while not thinking that he could improve on the method that was being employed he was asked to explain how he could repair the job.

His way was to take some ⅛-inch copper sheet that was on board, make a ring a little longer than the port and the diameter of the chest, braze the seam, anneal same, and when in place peen the ring out so as to fill the zigzag openings of the port and make the ring fit tightly 1 inch above and the same below the openings.

This sounded very nice and the wedges were removed and the coppersmith set at work. He finished the job in eight hours. The chest cover was replaced, the stuffing box for the valve stem plugged, and the vessel on her next trip ran compounded with a receiver pressure of 110 pounds on the intermediate-pressure valve chest without a weep of steam coming through the covered ports. The vessel made 3,000 miles under these conditions before another cylinder was cast and made ready to replace the broken one. When the vessel went to the shipyard for the installation of the new cylinder the shipyard company took photographs of the old cylinder, showing how the copper rings were placed, and highly complimented the ship's engineering force on the neatness and effectiveness of the repairs, and it was all due to the advice of a man that, out of curiosity, took a look to see what the inside of a steam chest looked like, and of whom no one expected anything in the way of repairing engines.

I might add that this cylinder was heavily lagged with the ordinary asbestos lagging, which no one would consider as dangerous; but when the cylinder carried away, the asbestos was thrown in every direction and making such a dust that it was impossible to see a distance of more than two feet from where one stood. This lasted for several minutes, besides affecting the eyes badly and adding greatly to the confusion when things had to be done quickly. READER.

Fitting a New Cylinder Liner

The following is an account of how we fitted a new liner to one of the cylinders of the main engines of the old *Triumph,* while she was on the Pacific station, and although it is an old story it may be of interest to readers to-day:

It fell to the duty of the writer to line up the piston of the engine in question, when, after pulling the spring ring back so as to clean underneath it, I noticed a mark in the bottom of the cylinder, which on closer examination proved to be a crack about 5 inches long. Of course, I at once reported the same to the senior engineer, who, by the way, was an engineer in every sense of the word. Well, I marked the crack at each end, and after closing up we went outside Esquimault harbor for target practice; when we got back into harbor again, after about twelve hours' steaming, we found the crack had extended about 3 inches at each end. We then tried plugging the crack at each end with cast iron plugs, but after steaming again for a short time we found the crack still extending. Our chief then decided not to steam again with the old liner in. After getting the sanction of their Lordships we sent home to a well-known firm for a new liner, and after getting the old one out and landed on shore out of our way, the new one arrived at Victoria, B. C., on the same day that we landed the old one. We soon had the new liner out of its packing case, and I do not know what made our chief engineer think of it, but he asked me to measure it to see how it corresponded with a gage which I had made to the cylinder casing, when, to our utter dismay and astonishment, we found it to be 3/16 inch too large. How in the name of fortune such a firm could have made such a mistake passes my comprehension, for we had sent them a good gage made out of 1¼-inch round iron; besides, they had the drawings of the engines to guide them. However, there was the fact staring us in the face, and an unpalatable fact it proved to be.

Now, let me here lay to rest a myth that was in vogue about the job I am about to describe, and that is the one about using the capstan as a vertical lathe. That yarn was sheer nonsense. What we did was this, for that liner had to be turned down to size. A strong timber platform was erected in the engine room, and the liner stood on this on its end. We then made a tool and tool-box with the necessary adjusting screws, and got the heaviest shot we carried in the ship to steady the tool-box. The stokers were then turned to to drag the tool round the liner, the writer of this standing at a fixed point to put the feed on after each revolution.* In this manner the surplus metal was taken off in three cuts. The liner was fixed and stationary. I think my readers will agree that for a turning job it was a creditable performance. Rigging the job and making all the appliances for same was only one of the many obstacles we had to overcome, for the great difficulty was to keep the liner in shape, for it warped and buckled in all directions. Wooden "shores" were placed inside at all available spots; these rendered the necessary trammeling an awkward job indeed. However, the job was at last completed so far as the machining was concerned. When we got it into position we found, to our joy, that it was a rattling good fit, for we had to force it with "jacks" for the last 6 inches of its getting home.

There is a point that I should refer to, for it goes to show what an amount of extra work can be entered into through neglecting to take wise precautions against errors. When we got the old liner out, rough templates were made to the bolt-holes in the cylinder. On taking the template on shore to finish it, it was applied to the old liner, and was found to be ⅝ inch out by comparison. This puzzled us, for great care had been exercised in making the template. The old liner was lying on its side when the template was applied to it, and on calipering it we found that it had sagged by ⅝ inch. Then the old performance of shoring it inside had to be carried out again before the template could be finished.

It took just seven months from the time we started pulling to pieces until we had our steam trial. During that time we had the loan of one fitter E. R. A. from another ship, which brought our working staff up to three fitters, one blacksmith, one coppersmith and two boiler makers.

We read of many troublesome breakdowns being repaired at sea, and under most trying conditions, but the writer questions whether ever, in the history of marine engineering, a similar job to the one described was ever carried out so successfully away from all the appliances of a dockyard workshop. Our senior engineer, who, by the way, was a splendid officer, was given two years' seniority for his share—and it was a big one—in the creditable performance; while the writer of these recollections was informed that their Lordships were pleased to promote him to a Chief E. R. A., a promotion that was much appreciated, considering the conditions under which the work was done.

Such are the bare outlines of how we turned down and fitted a new cylinder liner to H. M. S. *Triumph's* engines. I omitted to mention that when under steam the liner was perfectly tight and gave no further trouble.—*From an ex-Chief E. R. A. in The Artificers' Review.*

* It should be noted that the internal diameter of the cylinder was 78 inches, and it had five fitting strips on its outside.

Design of a Crank Shaft

In response to an inquiry the following is given to show the method for designing a crank shaft to fulfill the conditions stated herein:

Four-cylinder, triple expansion engine of 8,250 indicated horsepower.

Cylinder diameters, 32, 53, 61 and 61 inches.

Stroke, 48 inches.

Revolutions per minute, 120.

Piston speed, 960 feet per minute.

Steam pressure at engine, 250 pounds.

Length of bearings, 20 inches.

Distance between centers of bearings, 60 inches.

The diameter of a solid shaft and the inside and outside diameters of a hollow shaft are desired for this engine.

The allowable working stress for the shaft will depend upon the type of engine. If it is a naval engine which will develop the maximum power during only a small part of the engine's life, a much higher working stress can be allowed than if the engine is for a merchant vessel where the maximum power is to be developed all the time.

If we are dealing with a naval engine the steel for the shaft will probably have an ultimate strength of 95,000 pounds per square inch, and we can use a working stress of 9,000 pounds per square inch at maximum power. If we are dealing with a naval engine to work continually at full power, it will be better to use a working stress of 7,500 pounds per square inch. In the case of an engine for a merchant ship the steel will probably have an ultimate strength of 75,000 pounds to 80,000 pounds per square inch, and a working stress of 6,500 pounds per square inch will be permissible.

The mean twisting moment upon the section of shaft aft of the fourth cylinder will be

$$\frac{8{,}250 \times 33{,}000 \times 12}{2 \pi 120} = 4{,}330{,}000 \text{ inch-pounds.}$$

The maximum twisting moment will be about

$$1.25 \times 4{,}330{,}000 = 5{,}420{,}000 \text{ inch-pounds} = T.$$

The force acting to bend this section of shafting will be practically the same as the force acting to produce the maximum twisting moment, or

$$\frac{5{,}420{,}000}{24} = 225{,}500 \text{ pounds.}$$

We can assume the bending moment to be given by the formula

$$B = \frac{W\,l}{8} = \frac{225{,}500 \times 60}{8} = 1{,}690{,}000 \text{ inch-pounds.}$$

The twisting moment which will produce a stress equivalent to that produced by the combined twisting moment and bending moment is usually found by means of the formula,

$$T_1 = B + \sqrt{T^2 + B^2}$$

$$T_1 = 1{,}690{,}000 + \sqrt{(5{,}420{,}000)^2 + (1{,}690{,}000)^2}$$
$$= 7{,}365{,}000 \text{ inch-pounds.}$$

The diameter of the shaft to stand such a twisting moment can be found from the relation,

$$p = \frac{T_1\, y}{I_p}$$

p = stress in pounds per square inch upon extreme fibers.
y = distance from neutral axis to extreme fibers.
I_p = polar moment of inertia.

The expression for the polar moment of inertia of a solid circular section is

$$I_p = \frac{\pi D^4}{32};$$

and for a hollow circular section,

$$I_p = \frac{\pi (D^4 - d^4)}{32}.$$

D = outside diameter of shaft.
d = inside diameter of shaft.

If $d = c D$, then $I_p = \frac{\pi D^4 (1 - c^4)}{32}$

Solid shafts,

$$p = \frac{T_1 y}{I_p} = \frac{T_1 \frac{D}{2}}{\frac{\pi D^4}{32}} = \frac{5.1 T_1}{D^3}$$

Hollow shafts,

$$p = \frac{T_1 \frac{D}{2}}{\frac{\pi D^4 (1 - c^4)}{32}} = \frac{5.1 T_1}{D^3 (1 - c^4)}$$

Therefore for solid shafts,

$$D = 1.72 \sqrt[3]{\frac{T_1}{p}};$$

and for hollow shafts,

$$D = 1.72 \sqrt[3]{\frac{T_1}{p (1 - c^4)}}$$

If the inside diameter of the shaft is half the outside diameter, then $c = .5$ and $(1 - c^4) = .9375$.

If $c = .6$, then $(1 - c^4) = .87$.

In the present case the sizes of solid shafts for the various conditions would be as follows:

For a naval engine developing the maximum power for short intervals,

$$D = 1.72 \sqrt[3]{\frac{7,365,000}{9000}} = 16.1, \text{ use } 16\tfrac{1}{8} \text{ inches};$$

For a naval engine developing the maximum power continually,

$$D = 1.72 \sqrt[3]{\frac{7,365,000}{7500}} = 17.1, \text{ use } 17\tfrac{1}{8} \text{ inches};$$

For a merchant ship engine developing the maximum power continually,

$$D = 1.72 \sqrt[3]{\frac{7,365\,000}{6500}} = 17.92, \text{ use 18 inches.}$$

When hollow shafts are used with the inside diameter equal to one half the outside diameter, the sizes for the three cases will be as follows:

$$\text{Outside diameter} = D = 1.72 \sqrt[3]{\frac{7,365,000}{.94 \times 9,000}} = 16.42, \text{ use } 16\ 7/16 \text{ inches,}$$

Inside diameter = 8 3/16 inches;

$$\text{Outside diameter} = D = 1.72 \sqrt[3]{\frac{7,365,000}{.94 \times 7,500}} = 17.4, \text{ use } 17\ 7/16 \text{ inches,}$$

Inside diameter = 8 11/16 inches;

$$\text{Outside diameter} = D = 1.72 \sqrt[3]{\frac{7,365,000}{.94 \times 6,500}} = 18.3, \text{ use } 18\ 5/16 \text{ inches,}$$

Inside diameter = 9⅛ inches.

It will be noticed that the diameters of the hollow shafts are only 5/16 inch larger than those of the solid shafts.

Ann Arbor, Mich. EDWARD M. BRAGG.

Disastrous Accident to a Beam Engine

After a strenuous season steamboating on the St. John River, we are now in winter quarters and have more leisure time to read and compare notes of the season's breakdowns. The following perhaps will be of interest to some of the readers of INTERNATIONAL MARINE ENGINEERING, especially those old warriors of the beam engine type:

The passenger and freight steamer *D. J. Purdy*, operating on the St. John River, is fitted with a beam engine with a cylinder 32 inches diameter by 96-inch stroke, with Sickles valve gear. Steam is supplied at 55 pounds pressure per square inch by two leg boilers. The paddle wheels are 19 feet 6 inches diameter with feathering floats. The normal speed is 33 revolutions per minute with the engine operating on a vacuum of 27 inches.

We left our wharf at ten A. M., the machinery working as usual, when about three miles from the wharf the walking beam (which is of solid cast iron weighing about 2,600 pounds) snapped off at the air pump lever pin without any warning. On examination it was found that the piston was in five pieces, the piston rod bent 3 inches out of line, the cylinder cover in four pieces, the division plate between the bottom of the cylinder and the condenser in countless fragments, the guide rods sheared from their position, the broken end of the beam swung around, carrying away the top dashpots and steam and exhaust valve stems. Fortunately, none of the 200 passengers or crew aboard was hurt. The engine and boilers had just been under a rigid inspection of the Dominion boiler inspector.

It appears that four years ago there was placed in the bottom of the cylinder a cast iron piece 32 inches diameter by 1 inch thick to reduce the bottom clearance of the piston. This was fastened by four ¾-inch studs screwed into the division plate with a cast iron piece dropped over the studs and the ends of the studs riveted over. This cast iron piece was found cracked across the steam port opening, one-half being in place, the other half forced up on end (by the steam rushing through the port) and driven through the division plate on the down-stroke of piston.

When repairing the damage the cast iron piece was omitted, with the result that the knock, which was one of the peculiarities of the engine for years, disappeared entirely when the original piston clearance was allowed. Had this cast iron piece been securely and mechanically fastened in the first place, this serious breakdown that endangered the lives of the passengers and crew would not have occurred. Since repairs were finished the engine has given the best satisfaction.

St. John, N. B., Canada. JOSEPH WILLIAMS.
Chief Engineer, S. S. *D. J. Purdy*.

CONVENTION OF NATIONAL MARINE ENGINEERS' BENEFICIAL ASSOCIATION.—The thirty-eighth annual convention of the National Marine Engineers' Beneficial Association of the United States will be opened at 9 A. M., Jan. 20, at the New Charleston Hotel, Charleston, S. C.

Marine Articles in the Engineering Press

Greek Torpedo Boat Destroyers Lion, Panther, Hawk and *Eagle.*—These vessels, built by Cammell Laird & Company, Ltd., to the order of the Argentine Government, and subsequently purchased by the Greek Government, have a length of 285 feet, a breadth of 27 feet 7 inches, a depth of 17 feet 6 inches, and a draft of 9 feet in trial condition when carrying a load of 195 tons, the displacement being about 1,050 tons. The mean speed for six hours' continuous steaming was 32.2 knots, the propelling machinery consisting of independent compound impulse and reaction turbines of the Parsons type, arranged on two shafts, each turbine being in a separate engine room. No cruising turbines are fitted, but special nozzles are provided to the ahead turbines to obtain greater economy at cruising speeds. Five Yarrow boilers, fitted with oil-fuel burners of Messrs. Babcock & Wilcox design, furnish steam. The total bunker capacity is 250 tons of coal and 90 tons of oil. The armament consists of four 4-inch quick-firing guns, placed on the centerline of the vessel, and four 53-cm. torpedo tubes. 9 illustrations. 1,200 words.—*Engineering,* November 8.

Fuels for Internal-Combustion Engines.—A comparison is made between crude petroleum and producer gas as fuels for internal-combustion engines. The point is made that suction gas is not only more economical to run but that it is much cleaner. Anthracite coal, coke or charcoal may be used in the producer, the kind of fuel having a marked influence upon the cost of power production. Installations of marine suction gas producers, as furnished by various builders, are described. The types of boats in which such installations have been eminently successful are described, together with some discussion as to the cost of installation and operation. 7 illustrations. 2,900 words.—*The Marine Engineer and Naval Architect,* October.

Ramsay Patent Marine Governor.—The Ramsay governor is a device designed to prevent racing of marine engines. It is anticipatory in nature; that is, it operates before racing can take place, and this anticipating movement of the governor can be adjusted in a few seconds to any degree of delicacy that may be considered necessary to suit the trim of the ship. The throttle valve of the engine is operated by an atmospheric power cylinder and piston. The piston valve is operated by an arm carried by a tiltable tube containing a certain amount of mercury. This tube is placed fore-and-aft in the engine room, and the flow of the mercury in the tube as the ship pitches acts as a lever to open and close the valve. 2 illustrations. 1,700 words.—*The Steamship,* October.

The Italian Tug Boat Savoia With Diesel Engines.—The tug boat *Savoia,* built by the Cantieri Officine Savoia, Cornigliano Ligure, Italy, and propelled by a Diesel engine, has the following dimensions: Length between perpendiculars, 98 feet; main breadth, 19 feet 8 inches; depth, 9 feet 2 inches; draft, loaded, 6 feet 3 inches; corresponding displacement, 170 tons. The engine has four cylinders, developing 280 shaft-horsepower; it is of the Savoia type, two-cycle, single-acting, working on the Diesel principle, with two scavenging pumps driven by the crank shaft. Two drawings and one photograph. 350 words.—*Engineering,* December 6.

Salvage and Fire Tug San Gerrano.—Messrs. Merryweather & Sons, Greenwich, have recently built for the Societa Anonima Bacini e Scali Napoletani, Naples, the tug *San Gerrano,* to serve as a harbor tug and for fire protection of the port; it is also capable of undertaking salvage work on a large scale. The vessel is 114 feet long, with a beam of 19 feet and a draft of 8 feet. It is divided into six watertight compartments. The propelling engines are of the triple expansion type of 500 indicated horsepower, giving the boat a speed of 10 knots. Steam is furnished by three boilers, one of the Scotch type sufficiently large to provide steam for the propelling engines at full power with natural draft, and coal fuel, and two of Messrs. Merryweather's vertical marine watertube boilers, capable together of performing the same duty. The latter are, however, fitted for liquid fuel and are operated with forced draft. The pumping installation is said to be the most powerful ever fitted to a vessel of this class. It comprises two centrifugal pumps, driven by vertical inclosed steam engines with forced lubrication. Each pump has a rated capacity of 700 tons per hour. In addition there are two double-cylinder, vertical direct-acting pumps, each of a capacity of 545 tons per hour working against a head of 300 feet. These are provided for fire duty. The total combined pumping capacity for salvage work is thus 2,490 tons per hour, and for fire purposes 4,000 gallons per minute. Five photographs. 620 words.—*Engineering,* November 15.

The Motor Ship Juno.—This article is a critical discussion of the construction and arrangement of the Diesel engine built by the Nederlandsche Shipbuilding Company of Amsterdam for the motor ship *Juno,* built by the same company for the Anglo-Saxon Petroleum Company. The ship is 258 feet long between perpendiculars, 45 feet molded breadth, 18 feet 6 inches draft, and displaces 4,300 tons with 2,675 tons of deadweight. The engine is of 1,100 horsepower, giving the vessel a speed of 10.5 knots. The *Juno* is compared with the *Vulcanus,* the pioneer Diesel engine ship, built by this company for the same owners, bringing out in detail the facts concerning some of the happenings to the *Vulcanus,* which were hitherto unexplained. The engine for the new ship differs considerably from the engine of the *Vulcanus,* and the author criticises quite severely the framing of the engine as being too light and insufficient for the purpose. Other alterations in the design noted are the method of driving the cam shaft, which is explained in detail, the abandoning of forced lubrication, the use of water in place of an air blast for cooling the cylinders, the simplification of the valve gear, the rearrangement of the air inlet to reduce the noise, the remodeling of the fuel feed system, which appears to meet with thorough approval, and the installation of small tanks for supplying solar oil to be used in connection with Tarakam to overcome its defects. The article then describes in detail the operation of the engine. All of the auxiliaries which are required to be at work while the engine is at sea, with the exception of the water circulating pump for the condenser, are driven off the main engines. The other auxiliaries consist of a 100 horsepower, two-cylinder Diesel engine, driving a three-stage vertical compressor placed between the working cylinders. This engine also drives the centrifugal cargo discharging pump by a long belt and the centrifugal bilge and circulating pumps by chains. There is also a horizontal Deutz engine direct-coupled to the dynamo for lighting purposes, and also driving a small auxiliary compressor and a steam turning engine. A donkey boiler is fitted in the engine room, which can be fired by the exhaust gases of the main engine or by liquid fuel. The reliability of this vessel, as well as that of all the other large motor ships to which the author had access, is commented upon most favorably. In this connection it is pointed out that where compressed air is to be used for driving winches, windlasses, steering gear, etc., a supply should be drawn from a set of receivers entirely independent of those used for starting the engine, otherwise serious accidents might result. 12 illustrations. 9,300 words.—*The Engineer,* November 15 and 22.

Electric Power in Railway and Marine Terminals.—By R. H. Rogers. This article shows what Seattle is doing to prepare itself for the trade boom which is due to follow the opening of the Panama Canal, and shows how electricity can and must be applied to all the details of the terminal business if they are to overcome their great and growing handicap. The Bush Terminal, Brooklyn, N. Y., is cited as practically the only complete example of a modern steamship terminal, and it is pointed out that not only Seattle is working up a definite plan for progress in this direction, but also other cities, especially Boston, Los Angeles, San Francisco, New Orleans, etc., are waking up to the necessity for improving their waterway terminals. 9 illustrations. 2,500 words.—*General Electric Review,* June, 1912.

Motor Ship Rolandseck.—The *Rolandseck,* a ship 290 feet long, 40 feet beam, carrying 2,700 tons on 18 feet 4 inches draft, built by J. C. Tecklenborg, A. G., of Geestemunde, is propelled by a Carels-Tecklenborg six-cylinder engine with two-cycle cylinders, 20 inches by 36 inches, giving a horsepower of 310 for each cylinder. The engine with its self-contained auxiliaries, but no other parts or piping, weighs about 180 tons. The auxiliaries include a donkey boiler, a four-cycle 100 horsepower two-cylinder Diesel engine, driving an auxiliary compressor and a smaller one of the same general design for the dynamo, together with steam feed pumps, turning engine, etc. The mechanical efficiency is given as 73 percent. With this efficiency the indicated horsepower is 1,860, which works out to a brake horsepower of 1,360 at 115 revolutions. The fuel consumption is given as .47 pound per brake horsepower per hour. The article criticises the mechanical details of the engine and compares it with similar installations in other vessels. 5 illustrations. 3,350 words.—*The Engineer,* November 22.

Competition in Shipbuilding.—In an editorial discussion of this subject, attention is directed to the remarkable increase in shipbuilding in Germany as compared with the activity in England. At the commencement of October the number of merchant vessels under construction in the German yards was 101, with a total of 468,000 tons. With additional orders booked since then it is stated that German shipyards now have contracts on hand that will provide them with employment during the whole of 1913. Some of the important contracts in hand come from the Hamburg-American Company, which now has under construction nineteen ocean-going steamers of a total of 270,000 gross tons. Three of these are fast vessels for the Hamburg-New York service, each being of 50,000 tons. The North German Lloyd has seventeen steamers under construction with a total of 155,000 tons, the largest of which is 35,000 gross tons. At the beginning of November the German tonnage was exactly one-fourth of that obtaining in the United Kingdom at the same time, whereas the tonnage of merchant vessels launched in Germany, 1911, was only one-fifth of that launched in the United Kingdom last year. 1,000 words.—*The Engineer,* November 15.

The German Naval Architects.—The autumn meetings of the Schiffbautechnische Gesellschaft were held in the Konigl. Technischen Hochschule at Charlottenburg, Nov. 22 and 23. Seven papers were read and discussed. The first was by Dr. Diesel on the early development of the Diesel engine. It applies strictly to the period in which his engine was first developed, and does not discuss the period prior to or subsequent to this particular time, which of course had an important influence on the present-day development of the Diesel engine. The second paper was by Dr. Haufhäusen on the motive media of the Diesel motor with special regard to ocean navigation. The oils in use on Diesel engines at present are distillations of the fundamental substances coal tar and petroleum. The relative values of the various distillates are compared according to the percentage of hydrogen which they contain. The author draws practical conclusions for the treatment of fuels in order to obtain the best results in Diesel engines. The third paper, by Professor Dr. Gümbel, dealt with the problem of surface resistance. Of particular importance was that part of the paper dealing with the relation of surface resistance to the total resistance of ships. Of the two kinds of surface resistance, the resistance proper which is independent of the area and bears a certain relation to the roughness of the surface and the eddy resistance which depends on the lineal dimensions of the surface, it was by experiment unnecessary to separate one from the other. The next paper, "Internal Stresses, Especially the Tensile and the Resulting Ailments in Structural Parts," was by Professor E. Heyn. Certain mysterious breakages of turbine blades led to an investigation of the phenomena which indicate that a system is liable to internal stresses that produce elastic alterations of form. The special method of investigation made it possible to throw light on the very complicated effects of internal stresses and to arrive at ways and means of meeting them. The intensification of internal stress effects due to the working of the materials at a blue heat was illustrated, and this was considered to afford sufficient explanation of the well-known difficulty of working metals at temperatures within the limits of 150 degrees to 350 degrees C. The fifth paper, by Professor O. Flamm, dealt with the unsinkability of modern ships. The author shows that in connection with the German Bulkhead Rules, in which the curves given are concerned only with the sinking of vessels in a vertical direction without regard to their stability, and for a single draft. While the curves err on the safe side they should be revised to cover the matter of stability in individual cases. Professor Flamm advocated the institution of a central authority which should control the designs of sea-going vessels and that a class should not be given to such vessels until their qualities had been investigated. Three principal demands were formulated: (1) Replacement of the curves by exact calculations applied in each particular case; (2) the provision of sufficient stability to meet the case of a leaking vessel; (3) extension of the rules so far as to include all classes of vessels. The sixth paper, by Professor Otto Lienau, was on stresses in the longitudinal structure of steel merchant vessels. The principal results from investigations in this direction brought forth the following conclusions: (1) That the pressures exerted by weight of cargo and by water pressure respectively must not be discarded. (2) That the application of the longitudinal arrangement of the framing at the top and bottom parts of the longitudinal girder represented by the vessel brought with it an important reduction of stresses. Longitudinal framing at the sides and in the 'tween decks showed to less advantage, and the combination system was, therefore, considered to have approximately the same strength as the longitudinal one. The final paper, contributed by Oberlehrer Dipl. Mg. Herner, dealt with the reorganization of harbor dues and measurement for tonnage. The author makes the following proposals: The load displacement to form the basis of gross tonnage, in which case determination of the load line would have to precede that of the tonnage. The net tonnage to be identical with the cargo carrying capacity pure and simple, calculated by deducting from the displacement the weights of hull, machinery, coal, provisions, etc. Passengers to be included in the cargo. 12,250 words.—*The Engineer,* November 29, December 6.

Accidents to Lake Vessels.—During 1912 nineteen vessels on the Great Lakes were either total losses or constructive total losses. The most important loss was that of the steamer *James Gayley,* which was sunk in collision with the steamer *Rensselaer.* An analysis of the more important accidents developed the fact that nearly all of them could have been avoided by the careful observation of the rules of navigation.

All of the accidents since August 1 are tabulated in the article. 6,000 words.—*The Marine Review,* December.

Dominion Steamer Estevan.—The Collingwood Shipbuilding Company, Collingwood, Ontario, has just completed the twin-screw steamer *Estevan* to the order of the Dominion Government's Department of Marine Fisheries, and is especially designed to handle the lighthouse and buoy service on the Pacific Coast. The principal dimensions are: Length between perpendiculars, 200 feet; molded beam, 38 feet; molded depth to main deck, 17 feet 6 inches. The propelling machinery consists of two sets of triple expansion surface condensing engines having cylinders 15 inches, 25 inches and 42 inches diameter, with 26-inch stroke, running at 130 revolutions per minute. Steam is furnished by two Scotch boilers, 10 feet 6 inches by 14 feet diameter, working under Howden's forced draft. The steam pressure is 180 pounds per square inch. A special feature of the boat is the arrangement of a heavy derrick on the foremast for handling loads up to 30 tons. 1 illustration. 1,650 words.—*The Marine Review,* December.

The Use of Gases on Ships for Fire Extinguishing and Fumigation.—By E. Kilburn Scott. This paper, which was read before the Institute of Marine Engineers in November, is divided into two parts, the first dealing with fire extinction and the latter with fumigation. Four methods of extinguishing fire on board ship are enumerated: (1) Closing the hatches. (2) Flooding the holds with water. (3) Blowing in steam. (4) Blowing in inert gas, either carbon-dioxide, sulphur dioxide or flue gas. The various kinds of apparatus which have been developed commercially for fire extinguishing and fumigating are described in detail, as well as the installations of such apparatus. Information as to the properties of the various gases employed is given, as well as particulars relating to costs of the installation and upkeep. 11 illustrations. 9,000 words.—*Marine Engineer and Naval Architect,* December.

The Lengthening of the Aberdeen Liners Marathon and Miltiades.—Messrs. Alexander Stephens & Sons, of Linthouse, Govan, Glasgow, have recently lengthened by about 50 feet the Aberdeen White Star Liners *Marathon* and *Miltiades,* built by the firm in 1903. The length of these vessels was 455 feet on the water line, the breadth 55 feet, and the depth, molded to the upper deck, 33 feet. The portion added to each hull by the lengthening forms a new cargo hold having a cubic measurement of 83,000 feet and a cargo-carrying capacity of 1,200 tons deadweight. Space is also provided in the 'tween decks for accommodations for thirty first class and forty steerage passengers. No alterations or additions have been made to the propelling machinery except the provision of a second funnel, principally for appearance' sake. The article describes the process of lengthening these vessels. 8 illustrations. 2,000 words.—*The Shipbuilder,* December.

The Woermann Line Steamer Professor Woermann.—The single-screw passenger and cargo steamer *Professor Woermann* has been built for the Woermann Line by the Reiherstieg Schiffswerfts und Maschinenfabrik of Hamburg. The vessel is 391 feet 7½ inches long between perpendiculars, 52 feet molded breadth, 29 feet 6 inches molded depth to upper deck, 25 feet draft, corresponding to deadweight of 6,200 tons. The propelling machinery consists of one set of quadruple expansion engines with cylinders 26 inches, 38½ inches, 55½ inches and 81¼ inches diameter, with a stroke of 55 inches. The engines develop about 3,800 indicated horsepower at 70 revolutions per minute and are designed to give the ship a sea speed of 13½ knots when laden to about 22 feet 6 inches draft. Five single-ended cylindrical boilers with a total heating surface of 17,860 square feet supply steam at a working pressure of about 230 pounds per square inch. 3 illustrations. 750 words.—*The Shipbuilder,* December.

A Comparative Survey of Battleship Design.—This survey reviews only those types of battleships mounting the 12-inch gun. The vessels thus armed are divided into four distinct types: With guns in twin turrets carried on the center line and en echelon, on the center line only, on the center line and in wing turrets, and in triple turrets. The article is largely of a descriptive nature, enumerating and comparing the details of the various ships. German, Japanese, United States, Brazilian, Italian and Austrian ships of the line are discussed and their design and fighting qualities critically examined. The author concludes that the 12-inch gun era has practically closed. Credit is given to America for introducing the center line arrangement for turrets, to Germany and other nations for retaining the 6-inch gun, and to Italy for producing the triple turret. It is claimed that England has led in discarding the 12-inch gun before any other power, and substituting therefor the 13.5-inch and now the great 15-inch weapon, thus obtaining an invaluable lead over all other powers. 7 illustrations. 4,500 words.—*The Shipbuilder,* December.

The Argentine Torpedo Boat Destroyer Jujuy.—The *Jujuy* and her sister ship, the *Catamarca,* belong to a class of twelve vessels ordered by the Argentine Government from English, French and German firms in 1910. These two vessels were built by Freid. Krupp, A. G., at their Germania yard at Kiel. They are 289 feet 2 inches long over all, 286 feet 6 inches long on the water line, 27 feet breadth extreme, 17 feet ¾ inch depth, 8 feet 8½ inches normal draft, 995 tons normal displacement, 1,290 tons maximum displacement. The article gives a very detailed description of the construction and arrangement of the vessel, supplemented by a number of photographs and detailed drawings of both hull and machinery. The armament consists of four 4-inch 50-caliber quick-firing guns and four 53-cm. deck torpedo tubes of the Whitehead type, 21 feet long. The vessel is propelled by twin screws, each screw being driven by a Germania steam turbine of 12,000 shaft-horsepower running at about 640 revolutions per minute. The speed of the turbines is regulated, in so far as the change from the cruising to the normal speed is concerned, by varying the nozzle inlets to the first stage and regulating the maneuvering valve. For this purpose two sets of nozzles are provided, one of which is used for the cruising speed of about 15 knots and the other for the normal speed of about 28 knots. The turbines were tested in the shop up to 8,000 shaft horsepower. The steam consumption when developing 7,250 shaft horsepower was found to be only 12.25 pounds per shaft horsepower per hour. As this was only 60 percent of the full power, a still better result was to be expected at full load. The propellers are four-bladed, about 7 feet 6 inches diameter. The boiler installation consists of five small-tube water-tube boilers of the Germania-Schulz type, four arranged for coal burning and one for oil burning. Each boiler has a heating surface of 4,400 square feet and a grate surface of 97 square feet. The heating surface of the oil-burning boiler is 8,300 square feet. The working steam pressure is 260 pounds per square inch. It has been said that the German-built vessels of this group of destroyers have proved the most successful, and consequently the lengthy technical description of the vessel and her propelling machinery, together with the complete plans presented in the form of folding plates, will make this article of more than usual interest to warship builders. 11 illustrations, 2 plates. 4,000 words.—*The Shipbuilder,* December.

Contracts for New Destroyers.—Contracts for six torpedo boat destroyers for the United States navy authorized at the last session of Congress were awarded in December as follows: The William Cramp & Sons Ship & Engine Building Company, of Philadelphia, Pa., three vessels; the Bath Iron Works, Bath, Me., the Fore River Shipbuilding Company, Quincy, Mass., and the New York Shipbuilding Company, Camden, N. J., one vessel each.

INTERNATIONAL MARINE ENGINEERING

Published Monthly at

17 Battery Place New York

By ALDRICH PUBLISHING COMPANY, INC.

H. L. ALDRICH, President and Treasurer

Assoc. Member of Council, Soc. N. A. and M. E.

and at

Christopher St., Finsbury Square, London, E. C.

E. J. P. BENN, Director and Publisher

Assoc. I. N. A.

H. H. BROWN, Editor

Member Soc. N. A. and M. E.; Assoc. I. N. A.

AMERICAN REPRESENTATIVES

GEORGE SLATE, Vice-President

E. L. SUMNER, Secretary

Circulation Manager, H. N. DINSMORE, 37 West Tremlett St., Boston Mass.

Branch Office: Boston, 643 Old South Building, S. I. CARPENTER.

Entered at New York Post Office as second-class matter.

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Changes to be made in copy, or in orders for advertising, must be in our hands not later than the 15th of the month, to insure the carrying out of such instructions in the issue of the month following. If proof is to be submitted, copy must be in our hands not later than the 10th of the month.

McAndrew's Floating School

It is much easier for some to read a good story and remember the thousand and one ludicrous incidents related in it than it is to read a text-book, no matter how useful the information it contains may be, and it is for these men that we have begun publication of "McAndrew's Floating School," a serial story which tells how four young firemen, starting at the very beginning of a seafaring career below the grating of a steamship, gain the necessary knowledge for their advancement, step by step, to the positions of licensed marine engineers. All that the law requires them to know to get their licenses, either from the Board of Trade or the United States Steamboat Inspection Service, is woven into the story, so that the reader unconsciously absorbs a vast amount of practical and necessary information. The story is written by one of the best-known writers on marine engineering subjects, Captain C. A. McAllister, Engineer-in-Chief of the United States Revenue Cutter Service, a man who is by no means a stranger to many of our readers, since he has been a frequent contributor to our columns and was the author of the splendid engineering story, "The Professor on Shipboard," published several years ago. The new story that we are now publishing cannot fail to be of interest to every engineer, and it will be found particularly useful and helpful to the beginner.

The Technical Graduate

In view of the fact that shipbuilding is usually carried on of necessity by large corporations employing thousands of men engaged in a great variety of trades, it would seem natural that the system of management in such extensive enterprises would be developed to the highest point of economic efficiency, capable of dealing with every condition which would tend to strengthen its organization and produce the best possible results in face of the strongest competition; and yet cases are not infrequent, particularly in American shipyards, where there is a strange apathy on the part of the management to deal in a systematic way with the development of the technical graduate. Since the success of a shipyard depends largely upon the work of a competent staff of highly trained engineers, it is certainly a matter of some moment to look to the proper training of the recruits for this work. Are we to infer from the attitude of the management that the technical graduate is of little or no value to the shipbuilder? Or is this task of developing the technical graduate into a practical shipbuilder or naval architect too great a burden for the shipbuilder to undertake, considering the probable value of the technical man after he has secured a few years of practical experience?

There is no doubt that the technical graduate coming to the shipyard directly from an engineering school is heavily handicapped by the lack of practical experience, so that his first efforts in company with a force of trained apprentices and skilled mechanics are necessarily crude and perhaps of little value to the employer. But even so, it is certainly a shortsighted policy on the part of the employer to cast aside the technical graduate as a nuisance and a hindrance on the plea that he can secure from the ranks of his apprentices a more valuable man, thoroughly familiar with the tools, methods and materials involved in the particular work for which his services are needed immediately. There is, of course, a striking contrast between the technical graduate immediately after the completion of his course at an engineering school and the practical apprentice who has spent an equal length of time in actual work in a shipyard; but the relative value of the two types of men cannot be judged fairly by simply appraising the value of the raw material which, for the moment, both represent. The true value of both to the employer lies very largely in what can be made from the raw material. The technical graduate has a firm foundation of engineering knowledge on which to build, but he lacks practical experience. On the other hand, the practical man is thoroughly acquainted with the actual methods and processes of ship construction, but he lacks the strictly scientific training which is most essential for advancement. The most valued men in a shipyard must be technical men, no matter whether their technical knowledge has been gained partly from an engineering school education or almost wholly by practical experience in a shipyard or engine builder's shop, together with outside study; and the numerous examples of apparently equal progress and success of both types of men in the same field leads to the conclusion that both the technical graduate and the practical man have much in common that is of value, and that to neglect or slight available opportunities for aiding either is simply throwing away good material.

The methods employed in certain foreign countries for the training of technical graduates by practical work in the shipyards, as cited elsewhere in this issue, have much to commend them that is worthy of careful study. What has proved successful in these cases could undoubtedly be adapted to advantage to the conditions prevailing in America. Summer work for engineering students is of particular advantage, especially if backed up by a systematic scheme for providing a term of apprenticeship for the technical graduate, during which he would have a fair opportunity of becoming thoroughly familiar with all the activities of the shipyard, and the employer, in turn, would have an opportunity to gage his fitness for the more important work which is really the field for which he has been preparing as a life-work. The outcome in any case, of course, depends, among other things, upon the individuality of the man, and right here is a chance for the technical graduate to show the value of his education. Besides the engineering knowledge he has acquired, he has been under the influence of associations most beneficial to the development of character. He has faced the necessity of hard work, and plenty of it; he has been trained to learn rapidly, and has the ability to use his training in an emergency. Self-reliance, ambition and steadfast purpose are seldom lacking in the true technical graduate, and if the shipbuilder meets him half way he is almost certain to profit by these characteristics in the end. Otherwise, the technical graduate is likely to drift into other fields of engineering, and the shipbuilder will have lost a valuable opportunity to develop a most useful type of employee for his special needs.

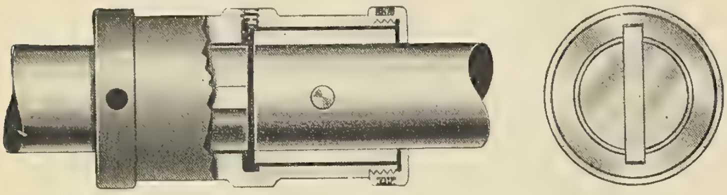
Port Development

With the nearing completion of the Panama Canal men in all parts of the United States are beginning to recognize the necessity, and, at the same time, the opportunity, for the investment of local capital in new steamship lines to meet the demands of increased commerce between ports on the Atlantic and Pacific Coasts and to South America through the Panama Canal. The possibilities for an immediate increase in commerce to the twenty countries of Latin-America is indicated by the fact that the foreign commerce of these countries last year exceeded a total of $2,300,000,000 (£473,000,000), a sum which represents a growth of $1,000,000,000 (£205,500,000) in the last ten years. The share which the United States has in this foreign trade will probably amount this year to as much as $700,000,000 (£144,000,000), and this, too, represents an increase of nearly 100 percent in the last decade. Under such conditions there is, therefore, excellent opportunity for an enormous advance in this commerce when the Panama Canal is completed. That the benefits of the Panama Canal are being recognized even more fully in foreign countries than in the United States is evident from the fact that the largest ports of Europe are spending now, or are preparing to spend, enormous sums for the establishment of new steamship lines or the extension of existing lines. It has usually been the policy in most European ports to look ahead and provide for the future in the development of port facilities. In almost every case, however, the progress in maritime commerce has repeatedly exceeded expectations and further development has been found necessary. Liverpool, for instance, is already severely embarrassed by the lack of adequate facilities to accommodate the existing commerce, and immediate steps are being taken for the relief of these conditions. It is strange that American ports should lag so far behind the general world-wide movement for the extension of port facilities, but the fact remains that most of them, and particularly the largest of all—the port of New York—has been at a standstill, so far as improvements are concerned, for several years. No less than thirty-two applications from steamship companies are on file waiting for terminal accommodations in the city. Steamships larger than the present piers can accommodate will be ready to enter the New York service within a few months, and still improvements are delayed. No more serious handicap can be placed upon the trade and commerce of any port than the lack of adequate piers and berthing facilities for the steamers which are available, and it is to be hoped that immediate and progressive action will be taken to relieve these conditions. No one can realize better the urgent need of immediate port improvement than the seaport authorities themselves, who are directly in charge of these matters, and an encouraging step has been taken in the United States by the formation of a national association of port officials, made up of the executive officials of all the important ports of the Atlantic, Gulf and Pacific Coasts, with the object of advancing port development projects by bringing into intimate relation those who are now directing such improvements along individual lines. The concerted action of such an organization should do much to bring before the public the best types of equipment to meet specific conditions.

Improved Marine Engineering Specialties

An Improved Steel Coupling for High or Low Speed Shafts

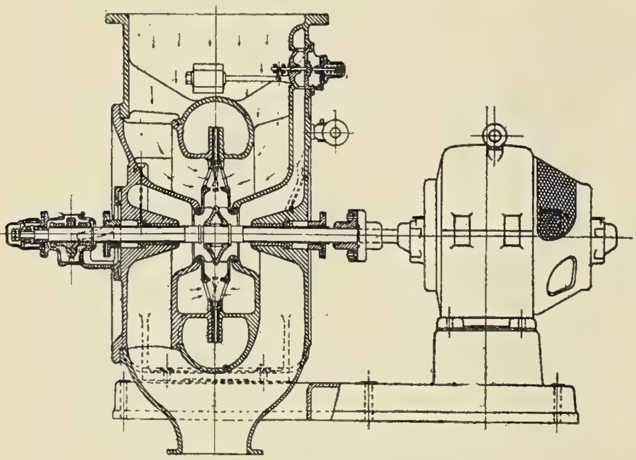
A new form of flexible coupling, made entirely of crucible cast steel and to dimensions especially suitable for this material, is being introduced by McEwen Bros., Wellsville, N. Y. This McEwen coupling, as it is called, and as illustrated herewith, is said to have the smallest diameter and mass, and therefore the smallest inertia of any truly flexible coupling on the market. The keys extend clear through the shafts, are set at right angles and are arranged to permit a marked degree of misalinement, yet because of ample key-bearing surface and the exceptionally good lubrication from packing of heavy



oil or soft grease, there is no noise or tendency toward serious wear. The design is particularly good for withdrawals parallel to the shaft axis, and very small clearance is required for removing any part. This type of coupling was first used, and has been given its severest test upon McEwen Bros. pumps, direct connected to steam turbines running twenty-four hours per day for months at a time. The satisfaction which it has given under these high speeds and other severe conditions as reversible motor drive for machine tools, would seem to indicate a general usefulness for blower, rotary pump, motor, generator and turbine and line shaft connections and on other machinery of any speeds.

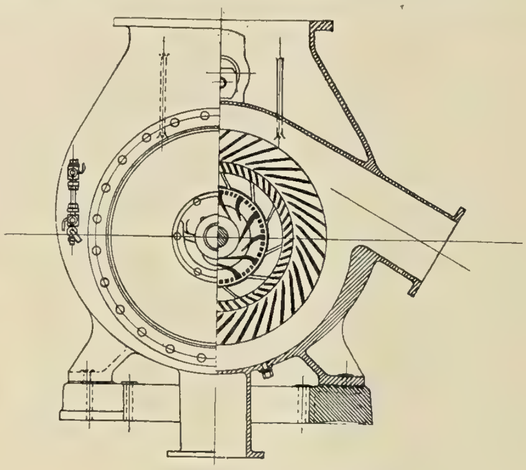
Rees Roturbo Rotary Jet Condenser

A new type of rotary jet condenser and high vacuum rotary air pump has recently been placed on the market by the Manistee Iron Works Company of Manistee, Mich., which is the American licensee of the Rees Roturbo Development Syndi-



SECTION OF ROTARY JET CONDENSER

cate, Ltd., of Wolverhampton. The new condenser is a development of the Rees Roturbo centrifugal pump, described in our October, 1912, issue, the unique feature of which is the employment of a revolving hydraulic accumulator or pressure chamber. In the case of the condenser this pressure chamber is used to lift the condensing water as an ordinary centrifugal pump would lift it to any height up to a limit of 20 or 25 feet, and give it an initial pressure after raising it. The water, therefore, flows up the suction pipe into this revolving pressure chamber or water drum, on the periphery of which nozzles are arranged. These nozzles allow the water to escape



END VIEW AND PART SECTION

from the pressure drum in radiating jets which are arranged to impinge in pairs. By this means the water jets are made fan shaped and subdivided into a fine spray, and are projected in lines radiating from the shaft (but still rotating as a whole with the impeller) across a space into which the steam is allowed to exhaust through openings. As these fan-shaped jets are rotating edgewise at a comparatively high speed, the area swept by them is very great, although the space occupied by the impeller is comparatively small. This, it is claimed, insures a perfect mixture of steam and water and an ideal condition for the most rapid and perfect condensation. After the water jets have traveled radially some distance, so that the broad parts of the water fans have all combined to form a complete ring of spray and condensed the steam, the problem, as in the case of all other condensers, is to extract the condensate and air with certainty and efficiency, and it is at this point that the new condenser differs in principle from all other types.

Instead of giving the water jets, as they leave the injection nozzles in the drum, sufficient energy to extract themselves from the vacuum chamber and carry with them without further assistance the air and condensate, the rotating jets of spray or condensate with the entrained air are in the Rees Roturbo condenser picked up by the blades of an exhausting fan concentric with the rotating pressure drum and of a much larger diameter, leaving a large steam space between the water drum and the exhausting fan, the whole forming a single rotary member. By means of the exhausting fan the condensate with the entrained air is ejected with absolute certainty and efficiency.

Fundamentally these rim blades are the equivalent of the mixing cone, and the neck or "shock zone" of the old ejector adapted to be rotated to give a positive exhausting effect, due to centrifugal force. These exhausting fan blades also form an automatic regulator, which deals with fluctuating conditions of steam or vacuum without any speed regulation. This feature allowing for long jets and a greater area for condensation than was possible even in the ejector condenser, as well as the impinging jets, which form the finest spray, enables the apparatus to be used for the largest size condensers, without any auxiliary apparatus for extracting the air or condensate, and carries all the advantages enumerated when used in the smaller sizes, as dry air pumps for surface and other types of condensers.

Waterprooofing the Floors of Piers

In building piers it is modern practice to specify that the floors, whether they be of mill construction or of concrete, should be thoroughly waterproofed. In the case of concrete, the solution is comparatively simple, inasmuch as painting with a preparation of boiled linseed oil thinned down with gasoline (petrol) will make the concrete impervious to moisture. Several coats of this should be applied until the oil shows glossy on the top.

However, in the case of mill floors the procedure is somewhat different. In the ordinary mill floor the construction usually consists of an under-flooring of 3-inch or 4-inch pine plank with a maple top of 7/8 or 1 inch and an intermediate

floor of similar dimensions. The general practice is to lay the top and under-flooring the length of the building, while the intermediate flooring is placed diagonally. Between the top and intermediate flooring is placed a waterproofing felt cemented together with an elastic compound, which snugly and tightly fills the nail points. Each sheet is lapped 19 inches over the preceding sheet of waterproofing, being turned up 2 inches at walls and openings, and also around columns, pipes, etc. At times to insure better results, as each plank of the top floor is laid, the hot compound is spread under it and over the felt already in place, making the joints between the top flooring itself practically watertight. Building paper could not possibly stand the severe conditions and a felt should be used which is absolutely impervious to water.

In this connection it is interesting to note the construction used at the steel and concrete piers of the North German Lloyd Steamship Company. Here the mill floors were waterproofed with two layers of "Hydrex" waterproof felt under the maple floor wearing surface. This material is exceptionally pliable and elastic, and does not dry out and disintegrate from the effects of the ocean air and salt water. The floors of the auditorium and ball room on Young's Million Dollar Pier, of Atlantic City, are also waterproofed with this felt against the high waves and salt spray of the sea below. The felt has remained tough and flexible, while an ordinary building paper by this time would have become practically worthless. The Atlantic City pier is also waterproofed with the same material.

The value of waterproofing the floors of piers and docks where merchandise is stored below is not as generally appreciated as might be expected, when it is considered in cases of fire that floors properly waterproofed prevent the water from pouring through to the floor below and increasing the loss. Waterproofed floors confine the water used in extinguishing fires to a given area. The ordinary building paper cannot accomplish this result and simply keeps dust from going through floors. Fire underwriters and insurance companies strongly endorse waterproofing floors, and make an allowance on the insurance which soon pays for the installation of the waterproofing.

Marine Repairs by Thermit Welding

Welding by the thermit process, as carried out by the Goldschmidt Thermit Company, New York, is accomplished by pouring superheated thermit steel around the parts to be united. Thermit steel is produced by the mechanical reaction between finely divided aluminum and iron oxide when ignited. This reaction when started in one spot continues throughout the entire mass without the supply of heat or power from outside sources, and produces superheated liquid steel and superheated liquid slag at a temperature of approximately 5,400 degrees F. From thirty seconds to one minute is sufficient time to bring into reaction almost any amount of thermit.

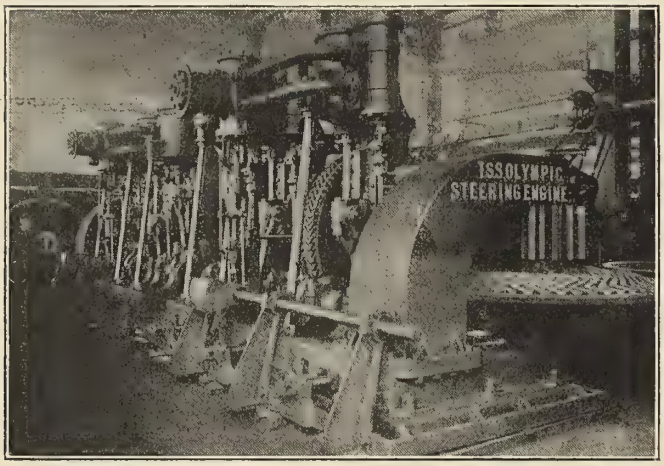
In repairing broken stern posts, rudder frames or rudder stocks, as shown in the accompanying illustration, a mold is built around the ends of the sections to be united, after the sections have been thoroughly cleaned and enough metal removed to allow for a free flow of thermit steel. The parts to be welded

should be preheated by means of a gasoline (petrol) torch; the thermit is then ignited in a crucible suspended over the pouring gate of the mold, and then the thermit steel is poured. When the thermit steel is poured it dissolves the metal with which it comes in contact and amalgamates with it to form a single homogeneous mass when cooled. Unless the sections to be united are preheated before pouring the thermit steel they will exert a chilling effect on the incoming metal and prevent successful fusion.

One of the important advantages gained by this form of welding is the possibility of welding heavy sections of wrought iron or steel without removing them from their position on board a ship, and therefore effecting a great saving in time and expense over other methods of repair. Sometimes it is found unnecessary to place the vessel in dry dock in order to make the repairs, and aside from the supply of compressed air for the operation of pneumatic tools and the preheating torch, no outside power is required, and since all the materials and appliances used for making the welds are light and portable they may be brought to the job. Where parts to be welded can be removed without trouble or great expense, it is found economical to forward them to one of the company's shops, where the repairs can be made immediately.

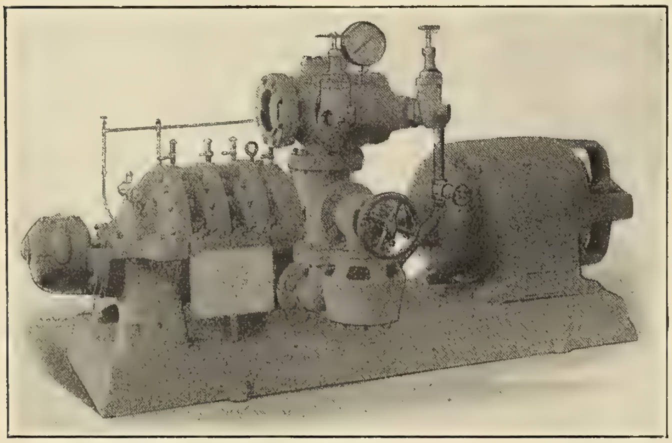
Citroën Gears

The accompanying illustration shows the steering gear for the White Star Liner *Olympic,* in which are used double Herring-bone helical reverse gears supplied by André Citroën & Company, 27 Queen Victoria street, London, E. C. These gears are of interest from the fact that they can be applied for the transmission of power under the most disadvantageous conditions. For reversing gears, such as are necessary in marine steering machinery, ordinary helical gears with the apices of the teeth running in a forward direction will rapidly wear out when called upon to reverse if transmitting the same load in both directions. To overcome this, the Citroën gears are made with three sections of the double Herring-bone type, as shown in the illustration, and this type of tooth is now being adopted for all reversing gear, especially in marine machinery. The Citroën gears are genuine machine-cut helical gears, as they have continuous teeth automatically cut with one tool in a single operation in the solid metal. This company has supplied gears for the steering machinery for a large number of battleships and submarine boats, as well as for merchant vessels.



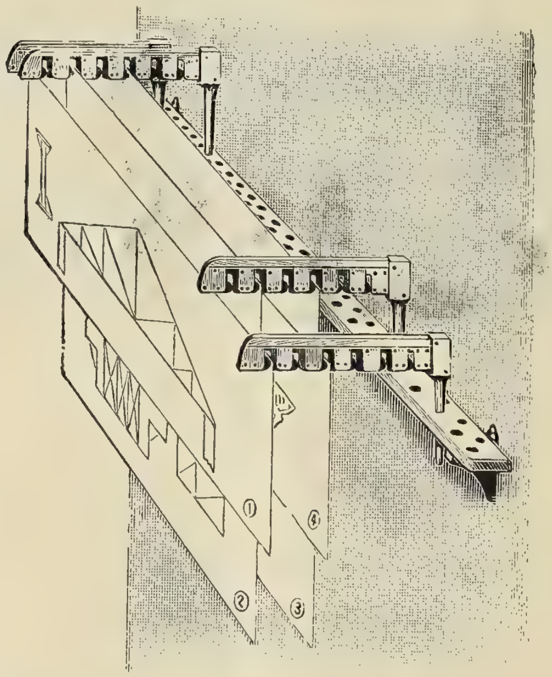
New Centrifugal Fire Pump

A new design of centrifugal fire pump has just been developed by The Goulds Manufacturing Company, Seneca Falls, N. Y., and is handled in England by Messrs. Gillespie & Beals, Amberely House, Norfolk street, The Strand, London. The outfit is furnished complete with pump, electric motor (a. c. or d. c.) or steam turbine, bed plate and all fittings required by the fire insurance companies, and it has been approved by the Association of Mutual Factory Fire Insurance Companies. Four sizes are furnished, with capacities of 500, 750, 1,000 and 1,500 gallons per minute, being sufficient for two, three, four and six effective fire streams respectively. All working parts are made of bronze to prevent any corrosive action from the water. The outfit illustrated is a 500-gallon equipment for two effective streams. With 250-foot leads of smooth hose and 1⅛-inch nozzle, the pressure at the nozzle is 50 pounds per square inch. This will produce an effective stream in a modrate wind at a vertical height of 70 feet and a horizontal distance of 63 feet. The motor with this outfit runs at 1,700 revolutions per minute and has an output of 50 horsepower. The overall dimensions of the complete outfit are: Length, 9 feet 7 inches; width, 6 feet 3 inches; height, 4 feet 9 inches.



Engineers' Photo Drying Rack

H. Schery & Company, Manchester, has placed on the market a convenient device for drying engineers' prints. The construction of the rack will be seen from the illustration. The mere insertion of the print into the clip will hold it securely, and a touch of the finger will release it again. The print is stretched out evenly over the whole surface and will, therefore, dry without creasing or crumpling. A number of prints can be dried at the same time occupying a very small space.



Technology Reunion.—The Alumni of the Massachusetts Institute of Technology, Boston, Mass., will meet for a two days' reunion at the Hotel Plaza, Fifty-ninth street and Fifth avenue, New York City, Jan. 17 and 18. The four principal events of the reunion will be departmental luncheons and a mass meeting on Friday, Jan. 17, and class luncheons and the annual alumni banquet on Saturday, Jan. 18. At the departmental luncheons on Friday the heads of the various departments at the Institute will tell something of what has been going on at Technology in recent years. Professor C. H. Peabody, head of the Department of Naval Architecture and Marine Engineering, will address the graduates of this course, and other men, prominent as naval architects and shipbuilders, will tell what is being accomplished by graduates of the Massachusetts Institute of Technology in their profession.

Technical Publications

STEAM BOILERS AND BOILER ACCESSORIES. By W. Inchley, B. Sc. Size, 4¾ by 7¼ inches. Pages, 412. Illustrations, 140. New York, 1912: Longmans, Green & Company. Price, $2.40 net.

As this book is intended to meet the requirements of steam users and engineering students rather than boiler manufacturers, it may seem incomplete to one familiar with the countless details of boiler shop practice. Technical details of boiler construction, such as the pitch of rivets, strength of plate, etc., are purposely omitted, however, since the class of readers for which the book is written is not necessarily concerned with such matters. A general description of various types of firetube and watertube boilers is given, and the questions of fuels and combustion, draft, generation of steam and heat transmission are thoroughly treated. A large amount of space is taken up with the description and explanation of the operation of every conceivable boiler accessory, the final chapters dealing with the practical operation of boilers and carrying out of steam boiler trials.

OXY-ACETYLENE TORCH PRACTICE. By J. F. Springer. Size, 5 by 7¼ inches. Pages, 140. Numerous illustrations. New York, 1912: The Richardson Press. Price, $2.50 net.

The welding and cutting of metals, particularly of boiler steel, by means of an oxy-acetylene torch, have become of such importance in recent years that most boiler makers are familiar with the general principles of these operations, and many have seen at first hand the results of the practical operation of the process. There is a vast difference, however, between experiment and approved practice, and it is the object of this book to set forth an accurate account of approved practice in the application of oxy-acetylene welding and cutting. The book was prepared with the co-operation of a prominent manufacturer of such apparatus, and is, therefore, based on wide experience and sound judgment. The book is not confined to boiler work; in fact, only a short chapter deals with boiler work; other parts of the book, however, deal in a complete manner with various types of sheet metal work, and of particular interest are chapters which take up the restoration of steel, welding as a calking process, and an investigation of the question as to whether or not oxy-acetylene cutting injures metal.

PRACTICAL DESIGN OF MARINE SINGLE-ENDED AND DOUBLE-ENDED BOILERS. By John Gray. Size, 5 by 7¼ inches. Pages, 84. Figures, 21. Plates, 4. New York, 1912: D. Van Nostrand Company. Price, $1.25.

It is claimed that this is the only book on the market dealing solely with the design of high-pressure single-ended and double-ended marine boilers. It is true that almost every book on boiler design or construction is concerned chiefly with the general principles of boiler construction and the details of stationary boilers, with perhaps a short chapter devoted to the design of marine boilers. A more complete treatment is needed, however, to enable a draftsman to work out the complete design of a Scotch boiler. In recent years steam pressures have steadily increased on board ship, and as larger ships and greater speed seem to be the prevailing tendencies in modern shipbuilding, it is necessary for the draftsmen or engineers engaged in their design to study in detail the construction of the large four-furnace high-pressure boiler. This book is an admirable aid for this purpose, and a copy should be in the possession of anyone who has to do with the design and construction of marine boilers.

A HAND-BOOK ON THE GAS ENGINE. By Herman Haeder. Translated by William M. Huskisson. Size, 6½ by 9¼ inches. Pages, 317. Numerous illustrations. London, 1911: Crosby, Lockwood & Son. Price, 18s. net.

This book comprises a practical treatise on internal-combustion engines for the use of engine builders, engineers, mechanical draftsmen, engineering students, users of internal-combustion engines and others. The original book was written in German, although not confined to German practice, and the work has been ably translated into English. It should prove of particular value to the engine builder or designer, because of the comprehensive treatment of the design of the various parts of an internal-combustion engine. In a single chapter there are seven sections which deal, respectively, with the crankshaft, the main bearings, frame, cylinder, piston, connecting rod, fly-wheel and relative costs of working gas and steam engines. The various parts of the engine are not only thoroughly described, but the methods of calculation, with questions and examples, place the material in convenient form for practical application. The book is profusely illustrated with line drawings and plates, and in an appendix there is a splendid collection of useful tables, which are a valuable accessory to gas-engine design.

THE STEAM TURBINE. By Robert M. Neilson. Size, 6 by 9 inches. Pages, 651. Illustrations, 415. New York and London, 1912: Longmans, Green & Company. Price, 18s. net.

As this is the fourth edition of this work the general scope of the book is probably familiar to many of our readers. This edition, however, has been completely revised and enlarged, to include important developments in design and use of steam turbines, which have taken place within the last few years. The greater portion of the previous edition has been re-written and much additional matter, including seven completely new chapters, has been added. The author's aim throughout has been to render the subject intelligible to the average British or American engineer, who has had a fair but not necessarily a very extensive scientific training. For this reason the theoretical part of the subject has been subordinated to practical descriptive matter, although the two, of course, cannot be separated. The part of the book relating to marine steam turbines is confined to a single chapter, and describes the application of different types of turbines for this purpose, together with illustrations of the arrangement of the installations.

AN UNSINKABLE TITANIC. By Bernard J. Walker. Size, 5 by 7½ inches. Pages, 185. 30 illustrations. New York, 1912: Dodd, Mead & Company. Price, $1.00 net.

This book is an earnest appeal for the construction of safer passenger vessels by embodying in their design a more minute subdivision of the hull. The famous *Great Eastern* is cited as an example of what the author considers the safest ocean liner ever built, and with this design are contrasted the defects of modern passenger vessels. This striking contrast is further emphasized by comparing the modern passenger steamship with warship construction, where minute subdivision of the hull is a leading characteristic. The book is evidently written for the popular reader, and if it is successful in augmenting the popular demand for safer steamship construction it will have served a useful purpose.

Obituary

ROBERT MCMILLAN, head of the firm of Messrs. Archibald McMillan & Son, Ltd., of the Dockyard, Dumbarton, died suddenly Nov. 2, at his home, aged 69 years. Mr. McMillan is the third generation of McMillans who have been actively engaged in the shipbuilding industry since 1834. This was the first firm in Great Britain to apply hydraulic power to the riveting of iron ships. Recently they have specialized in large cargo-carrying steamers, built on the Isherwood longitudinal system.

JOHN WILLIAM SHEPHERD, recently managing director of the London & Glasgow Engineering & Iron Shipbuilding Company, Ltd., Govan and Lancefield, Glasgow, died Nov. 24, in Glasgow, aged 68 years. Mr. Shepherd has had a very varied experience as a shipbuilder. From his early training in the Sherness Dockyard he has been prominently identified with many of the large Scotch shipbuilding firms.

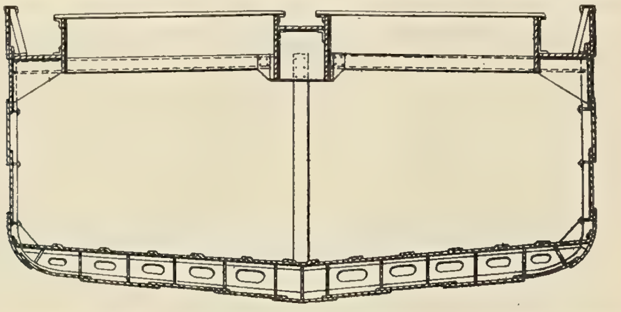
Selected Marine Patents

The publication in this column of a patent specification does not necessarily imply editorial commendation.

American patents compiled by Delbert H. Decker, Esq., registered patent attorney, Loan & Trust Building, Washington, D. C.

1,033,403. MULTIPLE-HATCH CONSTRUCTION FOR VESSELS. EDWARD S. HOUGH, OF SAN FRANCISCO, CAL.

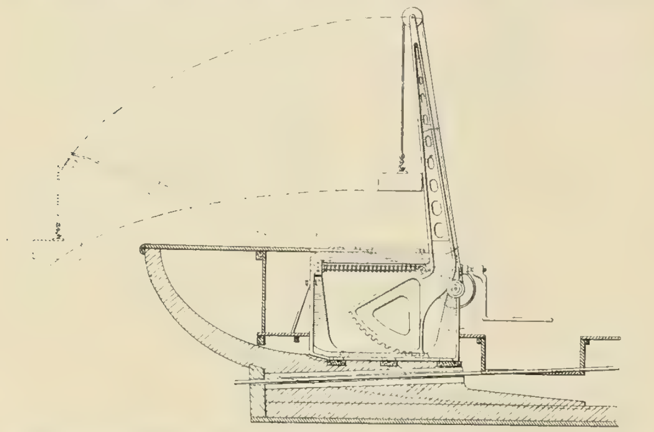
Claim 1.—A vessel having twin hatches, strengthening girders extending longitudinally upon each side of said hatches, a central girder



of inverted box-like form, vertical supports between said girder and the keelson, and transverse deck stays extending between the central and side girders. Two claims.

1,034,128. CRANE OR DAVIT. ANDREAS P. LUNDIN, OF NEW YORK, N. Y., ASSIGNOR, BY MESNE ASSIGNMENTS, TO ASTOR TRUST COMPANY, TRUSTEE, A CORPORATION OF NEW YORK.

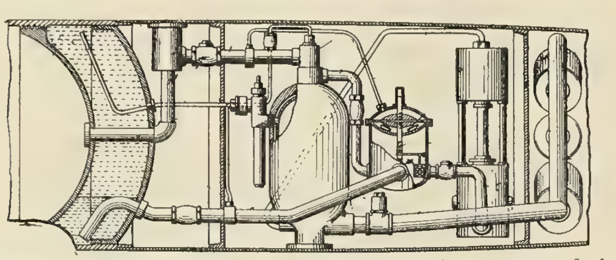
Claim 1.—A crane having a lower portion provided with a segment having two sets of teeth arranged on either side of a track, in combination



with a rack provided with an intermediate rail upon which the track rolls and two sets of teeth on each side of said rail adapted to engage and co-act with the teeth on the segment. Seven claims.

1,036,081. MOTIVE-FLUID-GENERATING APPARATUS FOR AUTOMOBILE TORPEDOES. GREGORY CALDWELL DAVISON, OF QUINCY, MASS., ASSIGNOR TO ELECTRIC BOAT COMPANY, OF NEW YORK, N. Y., A CORPORATION OF NEW JERSEY.

Claim 3.—In apparatus for generating motive fluid for automobile torpedoes, a generating chamber in which an oxygen-carrier and fuel are burned, means for supplying the oxygen-carrier under pressure to



the generating chamber, means dependent upon the pressure of the oxygen-carrier for supplying the fuel under pressure to the generating chamber, an ignition device, and connections whereby the actuation of the ignition device is dependent upon the pressure of the fuel. Eight claims.

1,035,021. SAFETY-WEIGHT FOR SUBMARINE VESSELS. MAXINE ALFRED LAUBEUF, OF PARIS, FRANCE.

Claim 3.—A submarine vessel provided with pockets fore and aft; a weight mounted in each of said pockets, the bottom of the weight standing at a point above the bottom of the hull of the vessel; and means located amidship for releasing one or the other or both of said weights and permitting the same to pass out of the pockets. Nine claims.

British patents compiled by G. E. Redfern & Company, chartered patent agents and engineers, 15 South street, Finsbury, E. C., and 21 Southampton Building, W. C., London.

14,314. ALLOYS FOR PROPELLERS. A. K. HUNTINGTON AND F. G. P. PRESTON, BOTH OF LONDON.

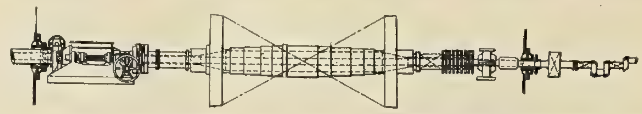
Alloys for use in making ships' propellers contain copper, zinc 34-42 percent and aluminium 1.75-4 percent, together with a little manganese and iron. Other constituents, such as lead, may also be present in small quantities, but the presence of tin and nickel is undesirable. Specification 232-10 is referred to.

20,383. ELECTRIC BOAT HOISTS. J. FIELDING, GLOUCESTER.

The object of this invention is to keep the electrically operated hoisting tackle of ships' boats taut as the boat rises and falls with the waves, and this is effected by interposing a suitable slipping clutch between the driving motor and the hoisting drum so that the motor may continue to rotate in one direction while the movement of the drum may be arrested or even reversed. A variable pressure betwen the clutch members may be applied by means of an electromagnet, the circuit of which is controlled by a switch conveniently mounted with respect to the motor switch.

21,977. PROPULSION OF VESSELS. A. F. YARROW, STIRLINGSHIRE, SCOTLAND.

This invention relates to the propulsion of vessels which are provided with two propelling engines, such as a steam turbine and an internal-combustion engine, for driving the same screw propeller. A hollow



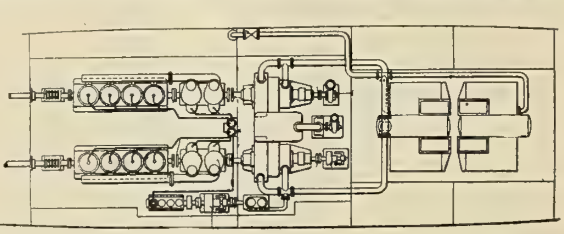
shaft is used for conveying power to the propeller from one engine, and another shaft passing through the hollow shaft for conveying power from the other engine, clutches being provided for coupling either engine to drive the propeller independently of the other engine.

24,324. CLUTCH AND REVERSING GEAR FOR MARINE MOTOR SHAFTS. A. G. LANGDON AND S. KELLAWAY, SOUTHAMPTON.

The apparatus comprises a double friction cone for the forward drive, the forward cone being keyed to the driven shaft, and the after cone being free to slide on the driven shaft. A stiff coil spring is fitted between the friction cones and extends to cause them to engage a double cone case, the forward end of which is connected to the driving shaft, and the after end with a toothed wheel keyed to the cone case, and mounted over this wheel is a drum provided with a band brake and carrying intermediate toothed gear, a portion of which comes into contact with the wheel on the cone case, the remaining part of the wheels coming into contact with another wheel keyed to the driven shaft, which runs right through the gear, and on which the friction cones are keyed so that a reverse is obtained.

10,240. ARRANGEMENT OF ENGINES FOR PROPULSION. GEBRUDER SULZER, WINTERTHUR AND LUDWIGSHAFEN.

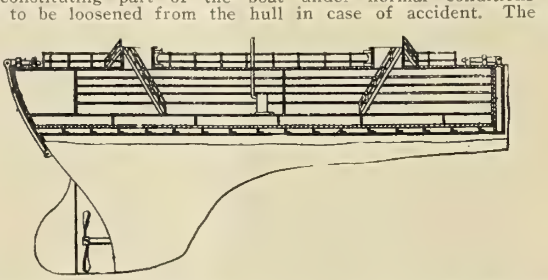
This invention relates to an arrangement of steam turbines and continuous-combustion internal combustion engines allowing ships to be always driven in the most economical manner. To this end charging and compressed air pumps are arranged in the length of the propeller shaft between the steam turbine and internal-combustion engine, these



pumps having clutch couplings enabling them to be disconnected or connected to the turbine or to the internal-combustion engine alone, or to both engines simultaneously, independent auxiliary machines, such as air pumps, bilge pumps, dynamos, etc.; being also capable of being coupled to the two engines working either jointly or independently.

11,858. SHIPS. R. S. CLIFT, QUEBEC.

This invention relates to ships provided with deck-houses or compartments constituting part of the boat under normal conditions and adapted to be loosened from the hull in case of accident. The side



plates of the hull are extended upwardly and overlap the sides of the pontoon to prevent lateral displacement of the latter. The pontoon is locked against rearward displacement by releasable devices consisting of arms pivoted to stanchions on the deck of the vessel and adapted to be swung down and secured between pairs of lugs on the deck.

International Marine Engineering

Published Monthly by ALDRICH PUBLISHING CO.

17 BATTERY PLACE, NEW YORK — 13 CHRISTOPHER ST., LONDON, E. C.

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Edited by H. H. Brown, A. M. Inst. N. A.
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Vol. XVIII — FEBRUARY, 1913 — No. 2

Great Lakes Steamers for Coastwise Service

During the past year the Great Lakes Engineering Works, Detroit, Mich., has built and delivered seven freight steamships for service in the Atlantic and Pacific coast trade. As the construction of ocean-going vessels is something of an innovation on the Great Lakes, these vessels have naturally attracted considerable attention.

The *Grayson, Borinquen, Yaguez* and *Bayamon* are owned and managed by the Ocean Freight Line, Inc., New York City, and the *Thompson, Raven* and *Ruby* are owned by the American Transportation Company and managed by Thomas W. Elwell & Company, New York City. All of these vessels are sister ships and all are so constructed that they can be easily converted into oil-burning steamers in the event of their going into the Pacific Coast trade when the Panama Canal is opened for traffic. They were built under special survey to Lloyd's highest class, and have the following principal dimensions:

Length over all	261 feet.
Length between perpendiculars	253 feet.
Beam molded	43 feet 6 in.
Depth molded	28 feet 5 in.
Load draft	24 feet.
Deadweight at load draft	4,050 tons.
Total cargo capacity	189,000 cubic feet.
Total bunker capacity	500 tons.

FIG. 1.—FREIGHT STEAMER ROBERT M. THOMPSON, BUILT BY THE GREAT LAKES ENGINEERING WORKS FOR THE AMERICAN TRANSPORTATION COMPANY

The vessels have two complete steel decks extending the full length of the ship. There are also poop, bridge, forecastle and boat decks all built of steel. Access to the cargo holds is by four hatches, two being 18 feet by 15 feet, one 22 feet by 15 feet, and one 26 feet by 15 feet, and in the 'tween decks there are three cargo ports 8 feet 6 inches by 6 feet on each side and in the bridge space one cargo port 5 feet 6 inches by 6 feet on each side. The decks are all supported by girders and wide spaced pillar stanchions, leaving the holds as nearly as possible unobstructed.

The coal is carried in wing bunkers the full length of the machinery space and in a cross bunker forward of the boiler room. On the last four ships these bunkers are constructed so that they can readily be arranged for fuel oil. The 'tween decks in way of the machinery space are arranged for either coal or cargo, having large watertight doors in the bulkheads at each end.

The quarters for the firemen and seamen are in the poop. The quarters for the officers and the remainder of the crew are all in a steel house on the bridge deck. The pilot house is located on the forward end of the boat deck and is of wood. 6-ton booms is all "durable wire rope." The 30-ton derrick has a 9-part fall and topping lift of plow steel wire.

The steering engine is located in the poop and geared direct to the quadrant, doing away with all the troubles which are attendant on chains and sheaves. The steering engine is controlled by a telemotor from the pilot house. There is a steam windlass on the forecastle deck with engines on deck below, and a steam capstan on the poop deck.

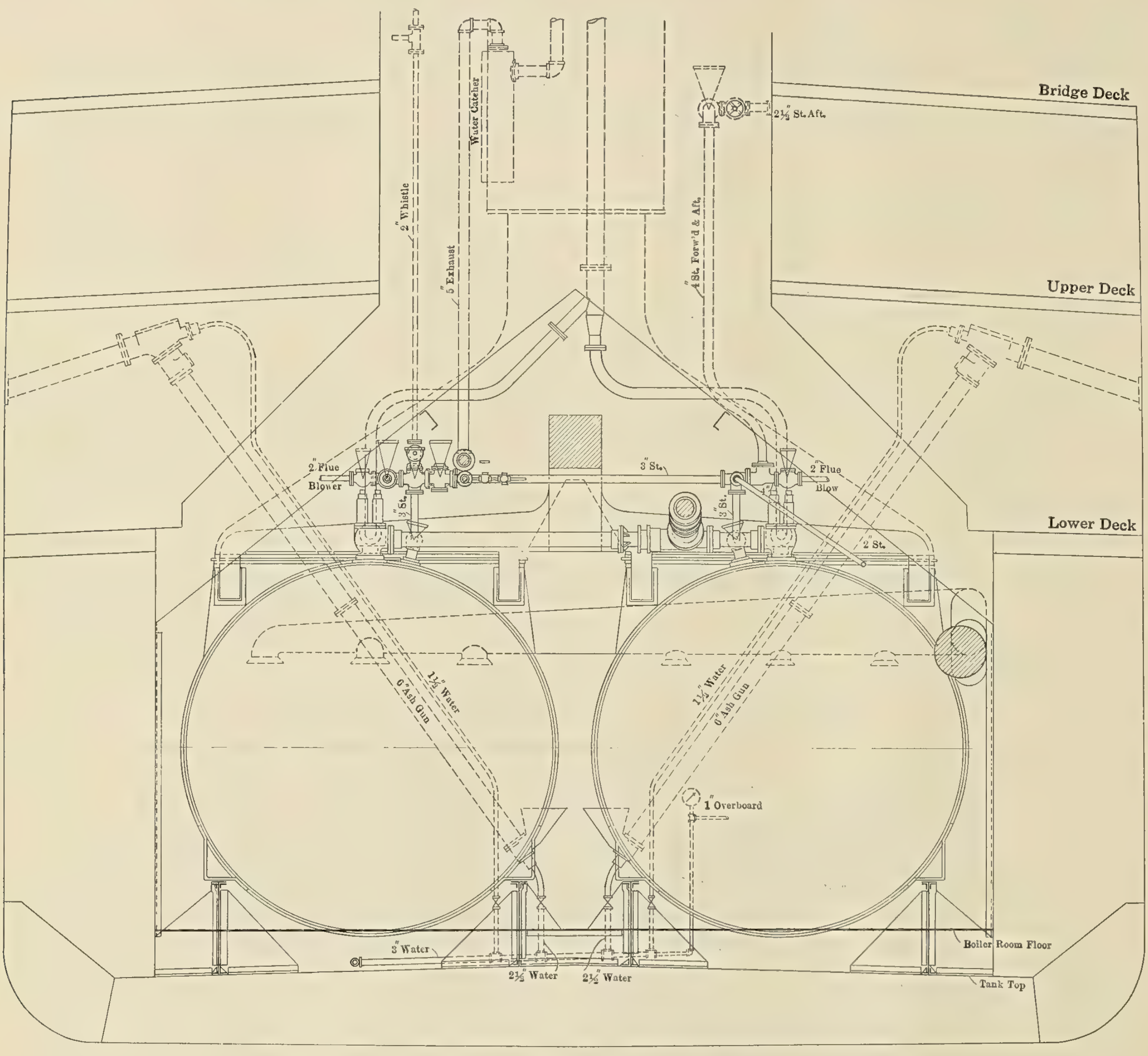


FIG. 2.—SECTION THROUGH BOILER SPACE

The quarters in the midship house are finished in oak. Aside from the interior finish of the cabins and the ceiling of the cargo holds, wood has been practically eliminated from these ships.

Deck Machinery

The cargo-handling gear is very complete. Each ship has two steel derrick masts. The foremast carries eight wood booms, each of 6 tons capacity and one steel boom with a capacity of 30 tons. The mainmast has seven wood booms of 6 tons capacity. There are eight cargo winches, all single drum with 8¼-inch by 10-inch cylinders. Two of the winches are double geared, of specially heavy construction for handling the 30-ton derrick. The standing rigging is all of galvanized plow steel wire rope. The running rigging for the

Boilers

Steam for all purposes is furnished at 180 pounds per square inch working pressure by two Scotch boilers, 14 feet 2 inches, mean diameter, 12 feet long over all. The shell plates are 1¼ inches thick, and each boiler has three 42-inch Morison furnaces made from material 35/64-inch thick. Each furnace has a separate combustion chamber, and there 323 2¾-inch tubes in each boiler.

The total heating surface of each boiler is 2,206.5 square feet, divided as follows: Tubes, 1,844 square feet; furnaces, 132.5 square feet; combustion chambers, 230 square feet. The grate surface of each boiler (with grate bars 5 feet long) is 52.5 square feet, making a ratio of heating surface to grate area, 42.02 to 1. Through the tubes the draft area is 10.8

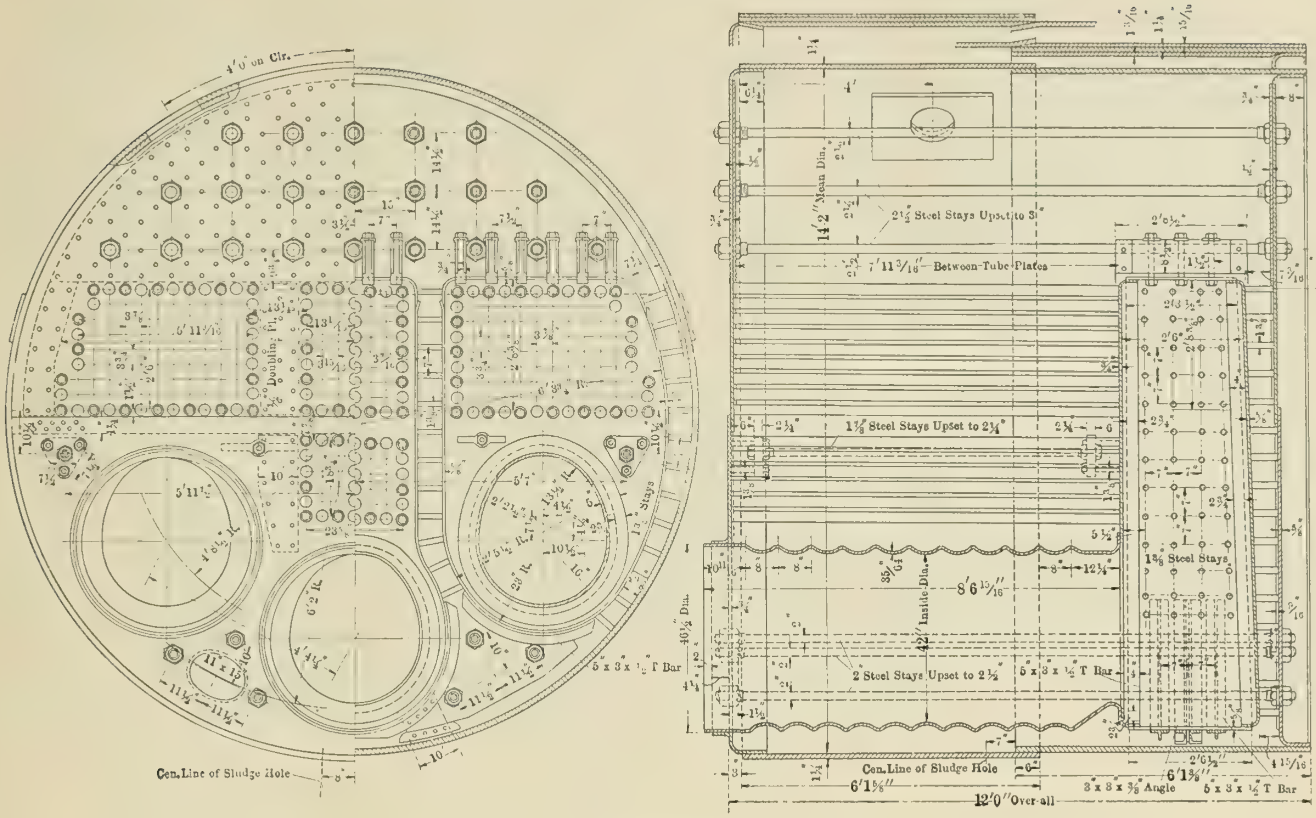


FIG. 3.—BOILER

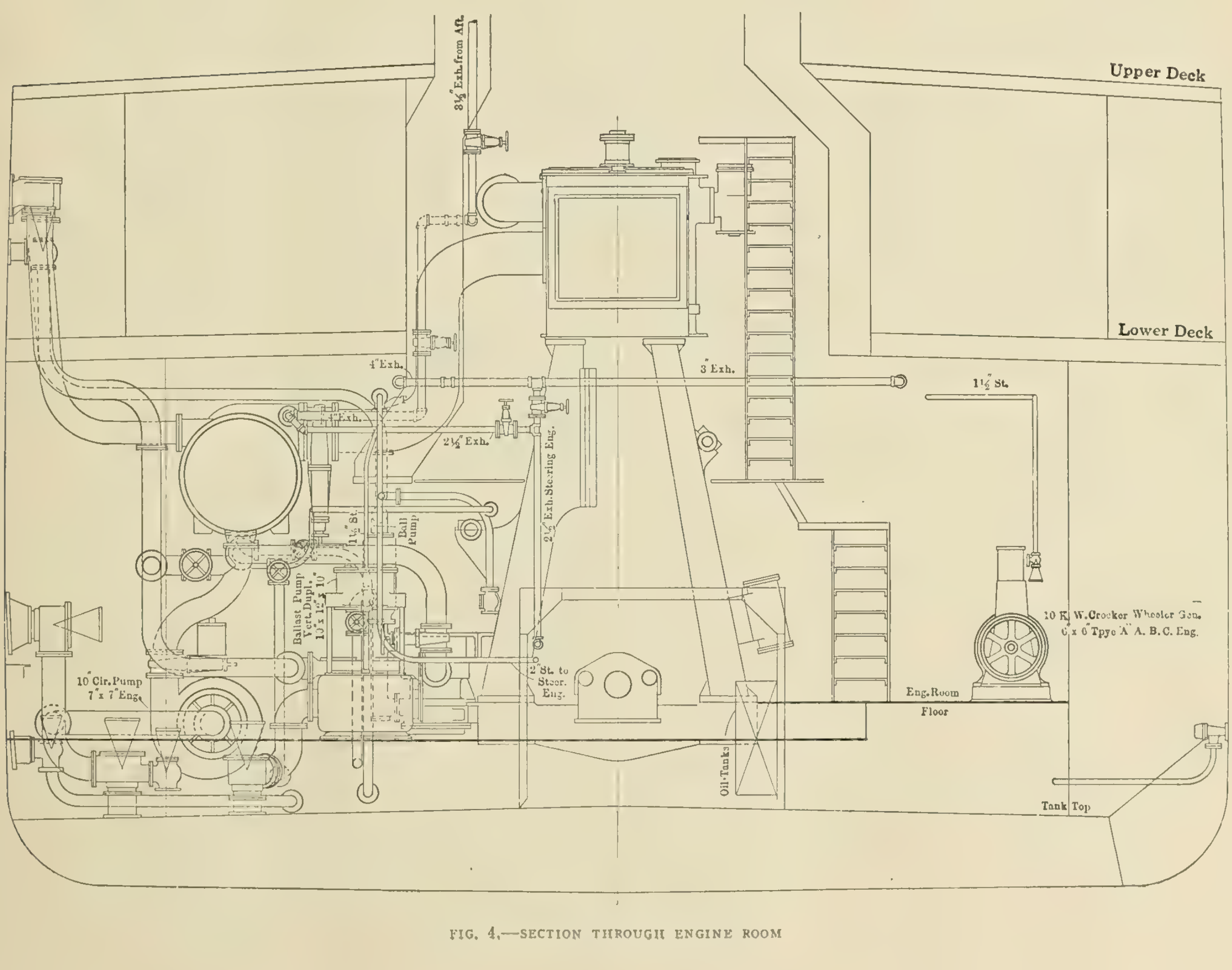


FIG. 4.—SECTION THROUGH ENGINE ROOM

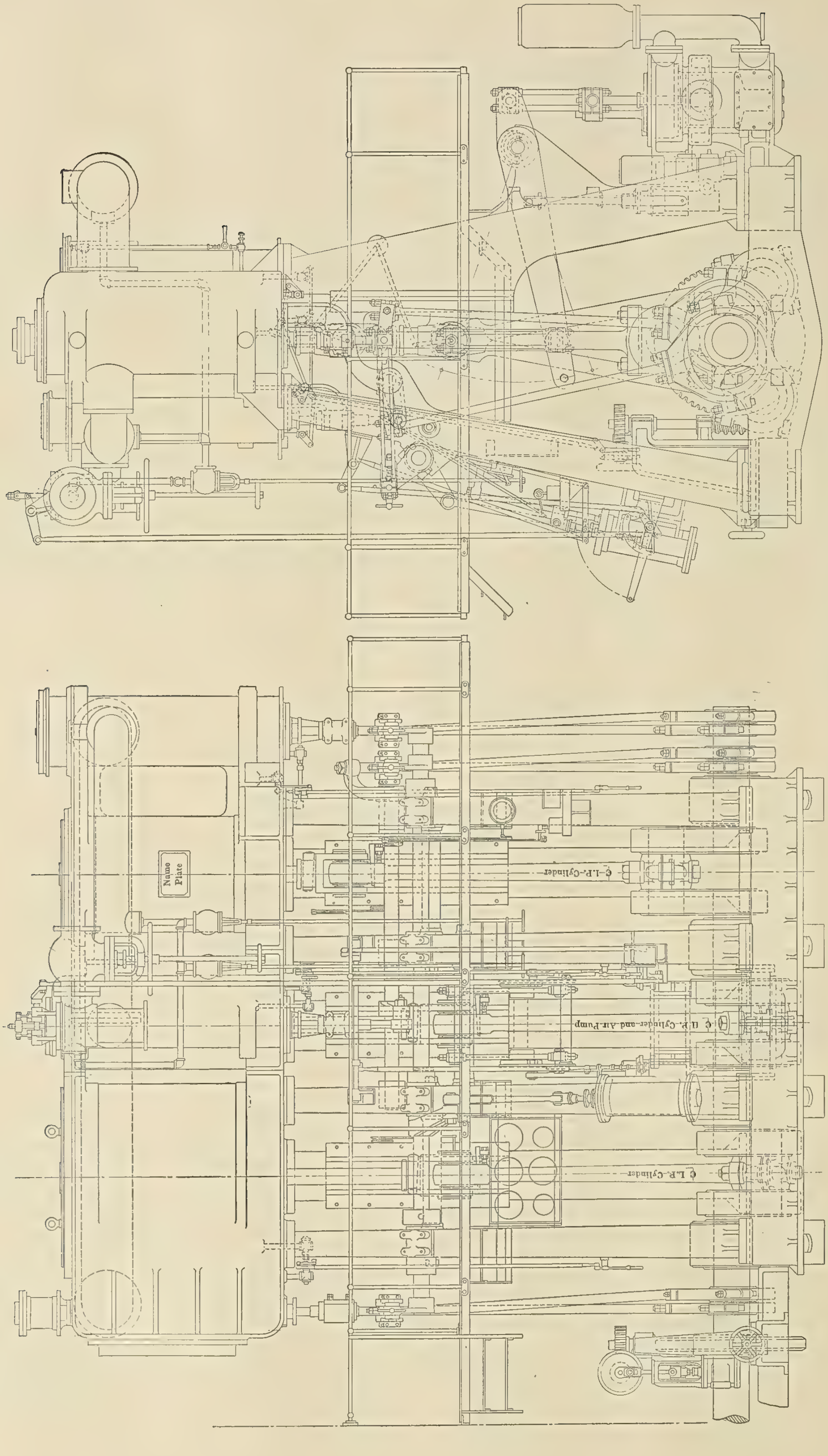


FIG. 5.—TRIPLE-EXPANSION ENGINE OF 1,480 HORSEPOWER FOR LAKE-BUILT COASTWISE STEAMSHIPS

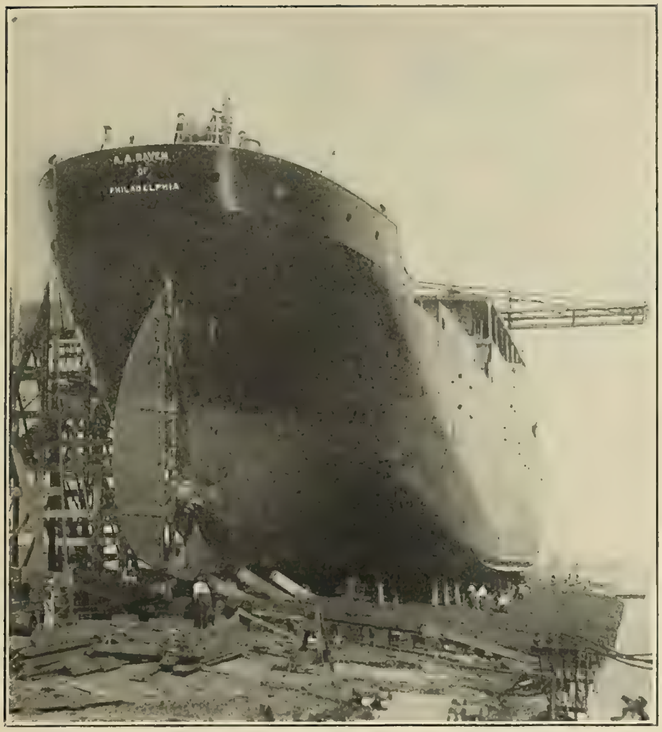


FIG. 6.—A. A. RAVEN ON THE LAUNCHING WAYS

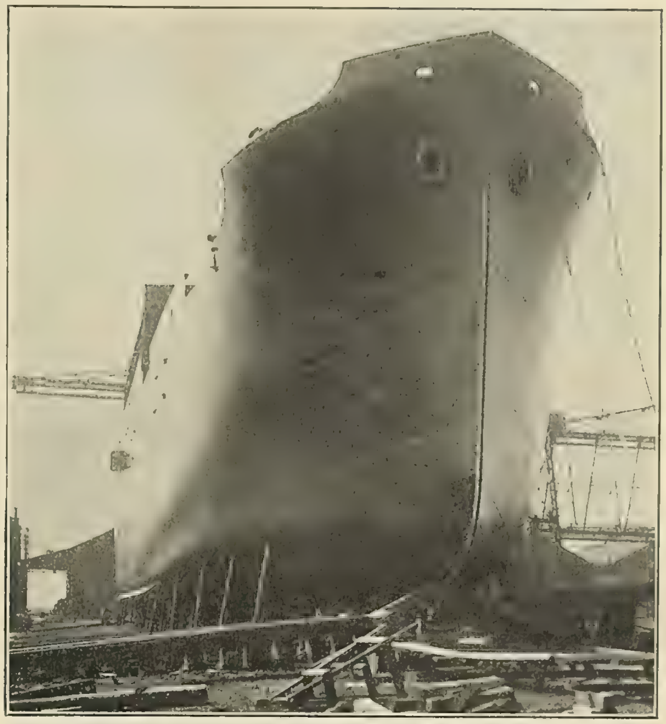


FIG. 8.—BOW VIEW OF THE RAVEN

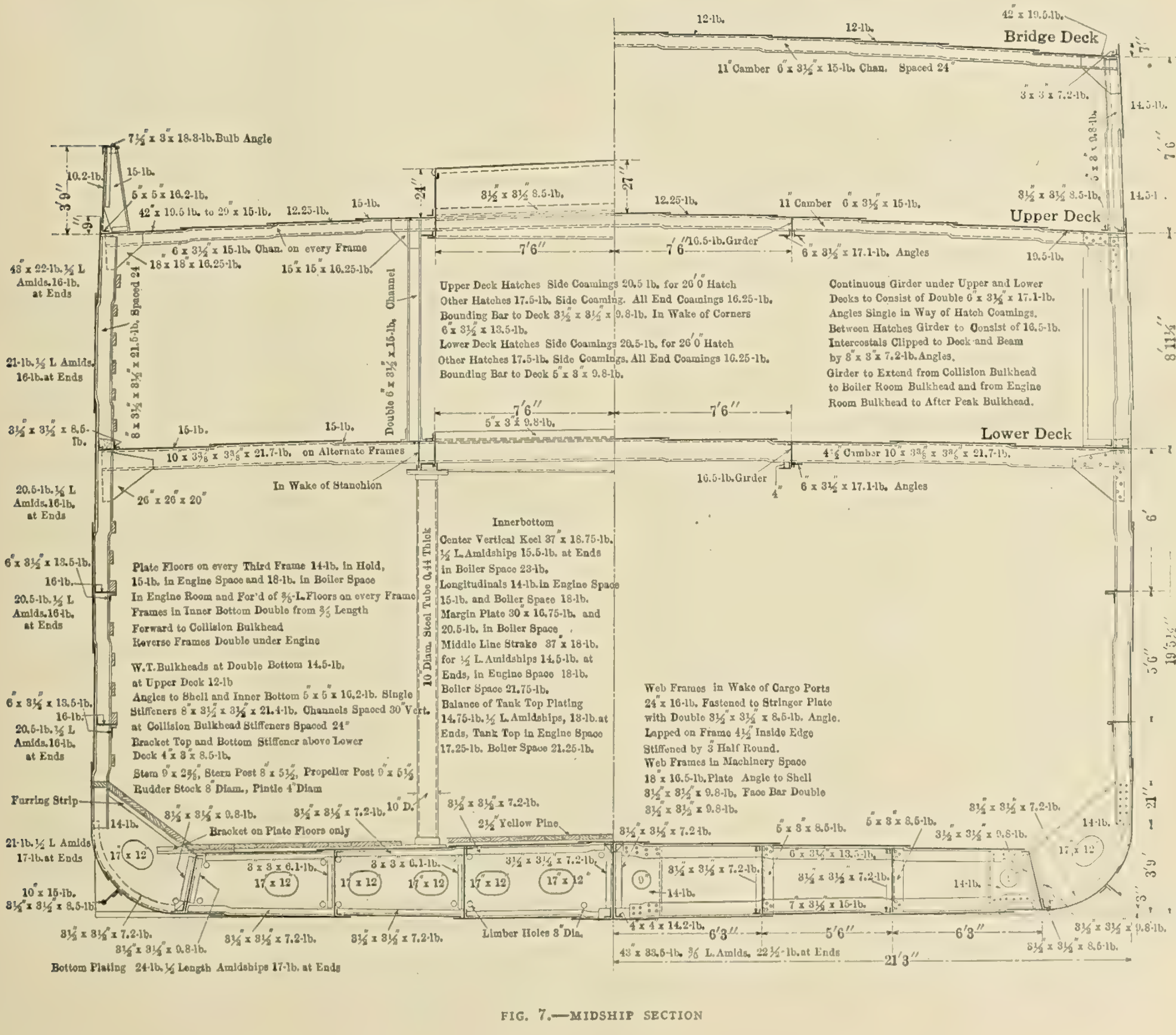


FIG. 7.—MIDSHIP SECTION

square feet, which makes the ratio of draft area to grate area 1 to 4.86.

Steam is conveyed to the main engines through pipes 8 inches in diameter, fitted with 6-inch stop valves. The auxiliary stop valves are 3 inches diameter. The boilers are so arranged that they can be fired directly from the 'thwartship bunker forward of the boiler room.

MAIN ENGINES

The ships are all single screw vessels, driven by a four-bladed propeller, 14 feet 3 inches diameter, having a variable pitch 14 feet 9 inches at the tip and 13 feet 9 inches at the hub. The developed area of the propeller is 68 square feet.

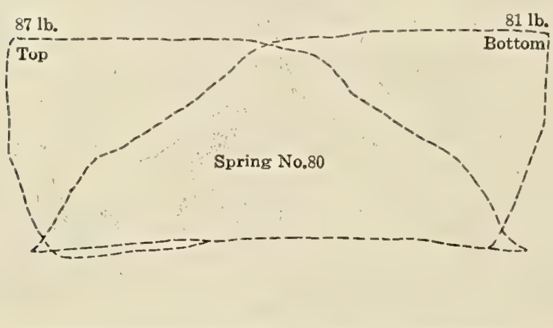


FIG. 9.—H.-P. CYLINDER. I. H. P., 524

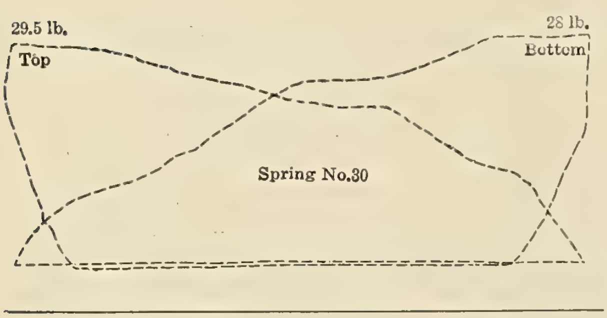


FIG. 10.—I.-P. CYLINDER. I. H. P., 489

The main engines are of the vertical inverted triple expansion type with cylinders 21½ inches, 35½ inches and 58 inches diameter, with a common stroke of 42 inches. At a speed of 83 revolutions per minute it is estimated that the engines will develop 1,480 horsepower.

In the arrangement of the cylinders the intermediate-pressure cylinder is placed forward; following this is the high-pressure cylinder, and aft is the low-pressure cylinder; the crank sequence being high-pressure, low-pressure, intermediate-pressure. Both the high-pressure and intermediate-pressure cylinders are fitted with piston valves and the low-pressure cylinder has a double-ported slide valve to the spindle of which a balance piston is attached. The high-pressure piston has deep removable solid followers, and the intermediate and low-pressure piston have special metal packing rings.

All the piston rods are 5 inches diameter. Annealed cast steel is used for the crossheads, and these are fitted with brass slippers for ahead and backing faces. The crosshead pins are 5¾ inches diameter by 8½ inches long. The connecting rods are of approved construction 8 feet 6 inches long center to center, made from open-hearth steel forgings. The diameter at the top is 4¾ inches and at the bottom 6 inches. Brass crosshead pin boxes are fitted with wedge adjustment. The crank pin boxes are of cast steel lined with Babbit and have bolt adjustment. All piston rods and valve stems are fitted with metallic packing.

The crank shaft is of the built-up type, having cast steel slabs which are shrunk on and doweled. The crank shaft is 11¾ inches diameter and the crank pins 11¾ inches diameter by 11½ inches long. The crank shaft is supported by four main bearings, two of which are 19 inches long and two 16 inches long.

The thrust shaft is also 11¾ inches diameter. It is fitted with five driving collars bearing against horseshoe-shaped Babbit-faced rings. The outboard shaft is 12 11/16 inches diameter in the body and 14¼ inches diameter in the stern bearing, which is 4 feet 4 inches long. The line shafting is 11 inches diameter in the body, enlarged to 11⅛ inches in the bearings, of which there are four.

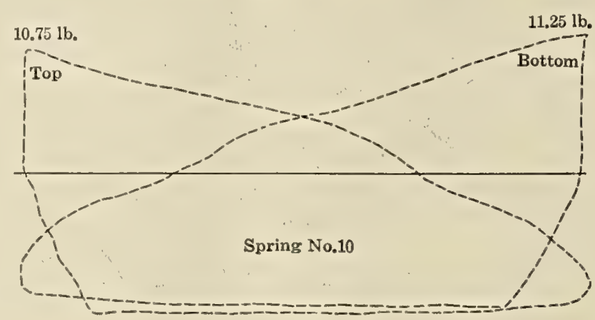


FIG. 11.—L.-P. CYLINDER. I. H. P., 499

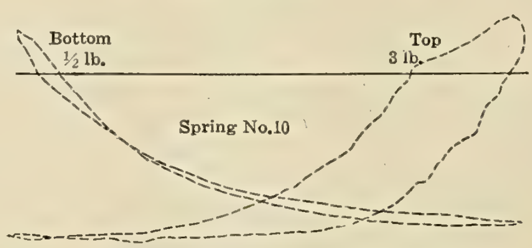


FIG. 12.—AIR PUMP. I. H. P., 1.91

AUXILIARY MACHINERY

The auxiliary machinery includes a vertical duplex ballast pump 10 inches by 12 inches by 10 inches; a 10-inch centrifugal main circulating pump, driven by a 7-inch by 7-inch engine; a vertical duplex feed pump, 7½ inches by 4½ inches by 10 inches; a donkey vertical duplex pump, 10 inches by 6 inches by 10 inches; a horizontal duplex general service pump, 6 inches by 4 inches by 6 inches; and a horizontal duplex fresh water pump, 4½ inches by 3¾ inches by 4 inches. The bilge pump is attached to the main engine and has two cylinders 4½ inches diameter by 12 inches stroke. The air pump is also attached to the main engine and is driven from the high-pressure crosshead. It is a double-acting pump, 18 inches diameter by 10 inches stroke. There is also fitted to the main engine a direct connecting reverse cylinder 10 inches diameter by 24 inches stroke, and a 6-inch by 6 inch single cylinder turning engine. The main condenser has a cooling surface of 2,125 square feet.

Positive draft is furnished by a single blower having a 36-inch wheel, 38-inch suction and a 24-inch by 24-inch discharge. The blower is driven by a 5-inch by 5-inch engine. A feed water heater, 25 inches diameter by 4 feet 4½ inches long, is provided, and the ship is lighted throughout by electricity, current being obtained from a 10-kilowatt generator driven by a 6-inch by 6-inch engine.

Figs. 9, 10, 11 and 12 show indicator cards taken from the engine of the *Ruby* on trial trip: Boiler pressure, 180; vacuum, 22.5 inches; revolutions per minute, 81; piston speed, 567 feet per minute; mean effective pressure referred to low-pressure cylinder, 33.3 pounds per square inch, and total horsepower, 1,512.

McAndrew's Floating School

BY CAPTAIN C. A. McALLISTER*

CHAPTER V

Engineering Materials

McAndrew, feeling somewhat encouraged at the interest which his class had shown during his remarks on elementary principles, decided that the next step in order would be to give them an idea of engineering materials, so he opened his remarks by saying: "Boys, what material is a cold chisel made from?" Three of them answered promptly, "Steel, sir." O'Rourke dissented somewhat by saying that he thought the one he had been using that day must have been made of lead, as he had to grind it so often. Paying no attention to the sally, the engineer pedagogue said: "Well, what is the difference between steel and iron?" As a deep silence followed the question, he remarked: "I thought you didn't know, and that's the reason I asked you. Since you have, I hope, absorbed a few ideas about elementary principles in engineering, I want to drill into you some idea of the materials used in building marine machinery.

"The first and most important of them is iron, man's most valuable metal." "What about gold, sir?" interjected O'Rourke. "I'm glad you spoke about that, as it shows that you think what most other people do. As a matter of fact, we could get along very well without gold, but we would have hard sledding to get along without iron. Gold is only valuable because of its scarcity, while iron is valuable on account of its usefulness. Luckily, it is found in great quantities in almost all parts of the world, and as it would be practically impossible to build marine machinery without it, we will try and see what cast iron really is.

"Since the days of old Tubal Cain, iron has been mined and utilized by mankind for all kinds of implements. It exists in a number of different combinations known as ores, some containing as high as 75 percent of pure iron. The first process after it is taken from the ground is to separate the iron from the other substances, and this is done in what are known as blast furnaces. The scheme is to mix the iron ore with coal or other fuel and melt the whole mass down by means of forced combustion of the coal, hence the term 'blast furnace.' The molten iron being heavier than the other substances, is drawn off at the bottom of the furnace, and being liquid is run along channels in a bed of sand, known as the pig bed, into depressions or molds in the sand about 3½ feet long, 6 inches wide and 4 or 5 inches deep. When these are cold they are known as 'pigs,' and thus we have the raw material known as pig iron.

"Pig iron, of course, varies in quality, as it is affected largely by the impurities of the coal, such as sulphur, silicon, etc., which get mixed with it during the melting process. In olden days, before wood became so scarce, and there were no Pinchots to say 'Woodman, spare that tree,' iron ore was melted down with charcoal, and consequently not so many impurities entered into the pig iron. That metal was then known as charcoal iron, and you can yet hear old timers bemoan the fact that they get so little of it these days. And it is a fact that genuine charcoal iron is now very scarce indeed. However, we get along quite well without it by having learned to make steel better and cheaper than the pioneers could.

"Now that you know something about cast iron, we will see for what purposes it is used on board ship. You all probably know that the cylinders are made of cast iron, always have been and always will be, as it cannot be improved upon for the purpose. It has sufficient strength to withstand the strain, will not melt or change under the heat, is readily machined, can be made into almost any form, becomes very smooth on wearing surfaces, and, above all, is very reasonable in price. That combination of qualities can never be excelled by any known metal."

"How strong is cast iron?" said Pierce.

"That's a good question," was the reply. "As I told you before, everything to be measured must have some standard of comparison. In the case of cast iron, the usual standard is what is known as its tensile strength per square inch. That means the number of pounds it would take to pull a bar one inch square, or one square inch in section, until it breaks. It is placed in a testing machine, which works very much on the principle of a beam weighing machine, and the weight or strain is gradually applied until the test piece breaks in two. The strength of the metal varies according to its quality and treatment, and its quality usually depends on the amount of impurities contained in the metal.

"First-class iron, such as used in cylinders, frequently has a tensile strength between 25,000 and 30,000 pounds per square inch. Other and poorer grades, such as are used in grate bars, furnace fittings, etc., have a strength of only 10,000 to 15,000 pounds to the square inch.

"Rigidity is the main feature of cast iron, and other tests, such as crushing and bending, are given to it, yet for all practical purposes the marine engineer is satisfied to know that it has the required tensile strength, as that is generally a guarantee that it will withstand any crushing or bending strains that will be placed upon it.

"Bedplates and condenser shells or walls are made of cast iron of fairly good quality, but need not be of such good material as that used for the cylinders. Guides, pistons, etc., are usually made of the best quality of iron.

"What is wrought iron, did you say? That's something you hear about, but very seldom see these days. Strictly speaking, wrought iron is literally pure iron, or iron with all other ingredients removed. Before we knew so much about steel making there were large quantities of wrought iron used about a ship; in fact, the ship's hull itself was built of it. The process of making it was to melt cast iron in what was known as a reverberatory furnace—that is, a furnace where the iron came in contact with the flame but not the fuel. By this means the carbon, etc., was burned out of the molten mass as well as could be, and men called puddlers stuck a bar into the boiling iron, rolled up a ball of it, like you would taffy, put it under a squeezer or hammer to squeeze out the dross, then either hammered or rolled it out into bars or sheets. This material could be forged, welded or rolled into almost any shape desired. The process of its manufacture was slow and expensive, and it has now been practically abandoned.

"Before I go any further I want to impress upon you the main distinction between cast iron, wrought iron and steel. Remember these fundamental facts and you will have the general idea:

"1. Wrought iron is pure iron with very little or no carbon in it.

"2. Steel is pure iron mixed with from one-tenth of one percent to sometimes one and two-tenths percent of carbon, according to the grade of steel required.

"3. Cast iron is iron mixed with about 3½ percent of carbon,

* Engineer-in-Chief, U. S. Revenue Cutter Service.

and with certain combinations even a higher percentage than that.

"You will thus see that the main distinction between these different grades of material is the amount of carbon they contain. To be sure, there are other ingredients in the mixture, such as sulphur, manganese and silicon in varying quantities. Sulphur is always bad, but certain small amounts of manganese and silicon are beneficial."

"What is this malleable iron we hear about?" inquired Pierce of the instructor.

"Malleable," replied McAndrew, "means capable of being hammered or rolled into shape, and although it sounds very good when applied to cast iron, you don't want to hammer it too vigorously or you will find that it will take the shape of two or three separate pieces, such as that two-inch elbow I saw O'Rourke wrestling with this afternoon."

"I didn't think you was looking when I busted that elbow," replied the guilty one.

"I saw it all right, and let that be a lesson to you that all malleable iron is not as 'malleable' as you might imagine.

"In making iron castings malleable, they are packed in some substance, such as mill scale or sand which will not melt, heated to red heat and allowed to stand for a number of days, during which time some of the carbon is withdrawn from the surface of the castings, which to a certain extent makes them tougher and more ductile. This process is used principally for small castings, such as pipe fittings. Some people claim that malleable iron can be welded; so, to demonstrate whether that claim is true or not, I'll have O'Rourke weld up that elbow he broke."

"Gee! I wish you would let me buy a new one instead," pleaded the Irish lad. "I'm not much on this scientific dope."

"To return to the subject," said McAndrew, "we will next take up the subject of steel, as used for shipbuilding.

"There are two principal processes used in the manufacture of structural steel, the Bessemer and open-hearth. As Bessemer steel is not used in any part of a ship, it will suffice to discuss the open-hearth process.

"This consists essentially of melting pig iron, scrap steel and wrought iron in a large circular furnace, sometimes as large as 20 feet in diameter, the heat being furnished by the combustion of gas over the top of the metal, so that, unlike a blast furnace, the fuel does not come in contact with the metal. This results in burning out the carbon in the mixture to a degree slightly less than that required in the steel to be made. In order to get the exact proportion of carbon required in the mixture, a certain amount of 'spiegel-eisen' is added."

"What's that, sir?" inquired O'Rourke.

"Ask your German friend," replied McAndrew.

"I don't know just what 'spiegel-eisen' is," replied Schmidt, "but in German it means looking-glass iron."

"That's right," said the instructor. "It gets its name from its bright surface, and it is really an iron ore containing a large proportion of manganese. This manganese unites with the oxygen and sulphur in the mixture and removes them. Spiegel-eisen also adds the requisite amount of carbon to the mixture. After it is determined by the man in charge of the furnace that the desired mixture is reached, the molten steel is run into ladles, from which it is poured into large molds which shape the metal into huge blocks of steel known as ingots. These ingots are, when needed, heated in a fiery retort to almost a white heat, and run back and forth through rolls until they are shaped into what are known technically as slabs and billets. In that shape they are selected to fill orders for boiler or ship plates and engine forgings, such as shafting, piston and connecting rods, columns, valve stems, etc."

"How can you tell this open-hearth steel from wrought iron?" inquired Nelson.

"Easy enough," interjected O'Rourke, "ask the man you buy it from!"

"That would be all right," said McAndrew, "if he knew the difference himself. As a matter of fact, it is very difficult to tell from appearances. Some people claim that they can tell by looking at it, but I have my doubts as to that. Others who are expert in working iron and steel can be reasonably sure by the way they cut. I remember once of being in doubt whether a certain lot of boiler tubes were of wrought iron or mild steel, and I could find no one who was absolutely sure as to the material of which they were made. There is one infallible way, however, of telling, and that is by cutting the metal in two, polishing up the surface and pouring on a little nitric acid. In wrought iron there is bound to be a certain amount of slag in the mixture which strings out in the rolling process and gives the metal the appearance of having a grain. When nitric acid is applied, the pure iron is eaten away and leaves the grain sticking above the surface. Steel being practically a homogeneous metal is eaten away uniformly by the acid.

"The next most important metal for marine machinery is brass, and I'll ask O'Rourke to tell you what it is."

Clearing his throat and assuming an air of importance at being called upon for an expert opinion, the son of Erin replied: "Brass is a metal that is mined—I don't know just where; it costs like blazes, smells bad, is 'pisonous' to the skin, gets dirty in five minutes, and is used around an engine room principally for the purpose of keeping the poor firemen busy shining it up when they ought to be resting themselves."

"That certainly is a very lucid description, and coming from such an expert on 'brass' it will have great weight. However, I cannot agree with all your conclusions, and especially as to its being mined.

"Brass, as it is commonly termed, is not an elementary metal, as it is composed of two and sometimes three elements, such combinations of two or more metals being known generally as alloys. An alloy composed of copper and zinc, or of copper, zinc and a very small amount of tin, is known as brass. When a larger proportion of tin or other metal, such as aluminum or lead, is used, the alloy is known as a bronze. As a matter of fact, the terms 'gun metal,' 'composition,' and 'bronze' are used rather loosely, and it is hard to draw a line of demarcation between them.

"The principal reasons for using brass, composition, bronze, etc., in the construction of marine machinery are their decreased friction when rubbed on other metals, their freedom from oxidization or corrosion, as it is commonly called, and in some instances for ornamentation. The latter reason is growing less every day, as there is plenty of other work on board a modern vessel to keep the firemen busy without having needless brasswork to polish.

"There are about a million different compositions of copper, tin, zinc, lead, antimony, iron, aluminum, etc., which can be made, but the principal ones of interest to marine engineers are the following, mixed in the proportions given:

"Common yellow brass: Copper, 65.3; zinc, 32.7; lead, 2.

"Babbit metal: Copper, 3.7; tin, 88.9; antimony, 7.4.

"Brazing metal: Copper, 84; zinc, 16.

"Admiralty bronze: Copper, 87; tin, 8; zinc, 5.

"Manganese bronze: Copper, 88.64; tin, 8.7; zinc, 1.57; iron, .72; lead, .30.

"Muntz metal: Copper, 60; zinc, 40.

"Navy composition: Copper, 88; tin, 10; zinc, 2.

"White metal: Lead, 88; antimony, 12.

"Phosphor bronze: Copper, 90 to 92; phosphide of tin, 10 to 8.

"Tobin bronze: Copper, 59 to 61; tin, 1 to 2; zinc, 37 to 38; iron, .1 to .2; antimony, .3 to .35.

"You probably will never be called upon to mix any of these compositions yourselves, and it is well that you will not, as it takes an expert to do it. However, it will do you no harm to know what goes into the various metals with which you will have to deal.

"There is another alloy which is rapidly coming in use for marine machinery, known as 'Monel metal.' Unlike other compositions, it is mixed by Nature itself, as it is in reality nickel ore just as it is mined. It is composed principally of nickel and copper in about the proportion of 65 to 35. It has been found to be very efficient for valve seats in steam valves where superheated steam is used, for pump rods and valve stems, and for propellers. The tensile strength is equal to that of steel, and it is non-corrosive in salt water and acids.

"I have now described to you in a general way the principal materials used in an engine room——"

"You have left the main ones out, Chief!" said O'Rourke.

"What are they?"

"Why, the gold and silver that are handed out once a month."

"You'll have to know a good deal more about steel and brass than you do now before you can connect very strongly with those metals," retorted McAndrew, as he dismissed the class for the evening.

(*To be continued.*)

Economy of Inclined Dock Elevator

The recent activity of the transportation companies and traffic organizations in general, in studying and analyzing the costs and methods of freight movement, has revealed some interesting facts and figures which show the economies and increased efficiency that can be effected by proper equipment at the terminal station.

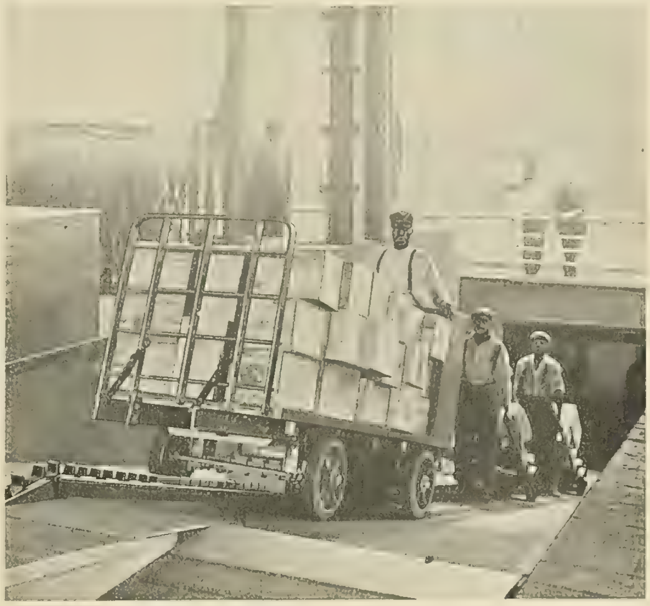
Many of the largest transportation companies have found the inclined dock elevator a most useful and practicable device for the movement of freight to and from vessels and the pier. As a result of their observations and studies, certain convincing figures are available which show clearly the savings in time, labor and money that the dock elevator makes possible.

The inclined dock elevator, which is built by the Otis Elevator Company, New York, is extremely simple in construction and operation, so that it can be installed on almost any gangway. It consists of an endless chain with projecting teeth or lugs, which travels in a steel channel over sprockets on each end. Where it is necessary to meet a variation in the height of vessels due to the rise and fall of the tide, a set of hinges of special design are furnished upon which the "inclined drop" may be raised or lowered. Through suitable spur gear drive a motor operates the dock elevator at speeds varying from 125 to 250 feet per minute. These speeds may be varied by an attendant through the use of a controller operated by hand. The truckmen bring their hand trucks or electric trucks to the inclined elevator, the lug of the moving chain engages the axle of the truck and the truck is carried on its wheels up or down the incline. The truckmen are relieved of the tiring strains at the incline and the movement of the trucks is accomplished rapidly and easily.

The current consumption is relatively small. When the dock elevator is running without loads on a steep incline, say at an angle of 25 degrees from the horizontal, to operate the machine requires but one horsepower. Suppose the dock elevator is loaded to carry 2,500 pounds of freight continuously for one hour up an incline 50 feet long, erected at an angle of 25 degrees, the chain moving at a rate of 250 feet per minute. To have a constant load of 2,500 pounds on the dock elevator at this rate, it will be reloaded every twelve seconds. In a minute, consequently, the dock elevator will carry up 12,500 pounds, or in an hour 750,000 pounds of freight.

The costs for power, under these conditions, at current cost of 5 cents (2½d.) per kilowatt hour, approximates 42½ cents (1s. 9¼d.) per hour. In other words, 375 tons of freight can be moved in an hour at a power cost of 42½ cents (1s. 9¼d). This case is cited to show the enormous freight handling ability of the dock elevator. Under ordinary circumstances it is not called upon to operate at full capacity, due to the fact that the trucks cannot be brought rapidly enough to the elevator.

The capacity varies, of course, according to the speed at which it is driven, the type of truck employed, and the speed at which the truckmen move their trucks. Ordinary hand trucks can be carried about ten feet apart. At a speed of 250 feet per minute, the machine is capable of transporting 1,500 hand trucks per hour. Running at a decreased capacity, the power costs are proportionately smaller. Now when it is remembered that from actual experiences fully 25 percent of the number of truckmen required under old-fashioned methods can be dispensed with, and that the remaining stevedores can individually perform the work of several men working under old-time methods, the savings in wages and time and the increased freight-handling capacity make the costs for power very small indeed.



INCLINED DOCK ELEVATOR, HAULING AN ELECTRIC TRUCK AT MERCHANTS' AND MINERS' DOCK, SAVANNAH, GA.

Mr. Albert Smith, general agent of the Metropolitan Steamship Company in Boston, Mass., has stated that the three inclined dock elevators which are operating on the Union Wharf not only have been the means of considerable saving in the cost of handling the cargo, but that it would take at least 25 percent more time to discharge the steamers without the dock elevator.

A very desirable effect is produced by this apparatus on the truckmen. Because of the rapid movement of the inclined elevator and the ease in ascending the incline, the truckman ascends at a trot. When the top is reached he must not slacken, because of the line of trucks behind him. This has a tendency to speed up all the workers and keep them moving at a dog trot on the levels as well as on the incline.

As mentioned before, the dock elevator is so built that the variations in tide cannot affect the usefulness of the machine. The vessels can be loaded and unloaded at ebb or flood tide with almost the same dispatch and ease. In some instances where the rise and ebb of the tide is very pronounced, the dock elevator has performed its work at a grade approximately 45 percent.

The Possibilities of the Marine Oil Engine

BY THEODORE LUCAS

In the rapidly extending development of new or at least, novel methods of power application to propulsion of ships, the possibilities of the internal combustion engine deserve an earnest and painstaking study.

The principal advantages of this type of engine may be summed up as:

(1) Small space, most pronounced with oil-burning engines.

(2) Light weight or possibility of further saving of weight.

(3) Rapidity in passing from no power to full power and vice versa.

(4) Absence of hot steam pipes.

(5) Absence of boilers which, by explosion, may endanger life of men and safety of ships.

The principal disadvantages of the type may be classified at the present stage of perfection as

(1) Employment of light volatile oils, like gasoline (petrol) or benzine as fuels, with the attending high cost and danger of explosion.

(2) Lack of reversibility in the propelling engine and lack of an always available power impulse for ready and handy stopping and starting.

(3) Lack of a handy, directly available power medium for operation of all the various auxiliaries on board of a large ship from one central source.

(4) Lack of a handy medium for heating and cooking in the living spaces similar to steam radiators or steam hot tables.

All these disadvantages are avoided by steam machinery, and the internal combustion engine will have to overcome them if it shall be able to fully compete with steam machinery. But if it is possible to solve these questions with satisfaction, then the internal combustion engine will supersede steam machinery, reciprocating as well as turbine. It may be of interest to indicate the way by which such improvement of the internal combustion engine may possibly, and even probably, be secured.

Among the fuels available for use in internal combustion engines, gasoline (petrol) and naphtha are the most convenient ones, as they can be evaporated without any residuum, and in this vaporized form can be mixed with the air needed for its clean and complete combustion. But every power user knows that the heavy oils, the kerosene (paraffin), and yet heavier products of petroleum distillation, and even the crude oil itself, have greater heat and power capacity per pound, while being much cheaper in price as well as much safer in handling and storing, than gasoline (petrol). The qualities of safety are due to the fact that the heavy oils are less volatile than gasoline (petrol). But this lack of readiness of evaporation, while excellent for safe storing, is not as convenient for getting the oil into the engine in such form as will allow a ready mixture with air and a clean and complete combustion.

The fact of there being two methods of fuel combustion in internal combustion engines is often lost sight of. These methods are:

(1) Explosive method.

(2) Combustion method.

The first one is used by engines frequently called the constant volume type, while the second one is used by those called the constant-pressure type.

The first, which is the best-known one, is used in all, or nearly all, classes, and makes of gasoline (petrol), light oil, or gas engines. The fuel charge is generally evaporated by and mixed with the ingoing admission air and forms with it an explosive mixture, which, after suitable compression, is ignited by an electric spark.

This method has also been tried for heavy oils, but with much less success, as these fuels cannot be readily evaporated by an air current, but need application of heat, which is apt to dissociate them and throw down tar or carbon, that will foul and eventually clog the engine.

Fortunately the combustion method can deal very successfully with the heavy oils. The principle upon which engines can be operated by this method is to provide in the cylinder sufficient heat for immediate ignition and complete combustion of the heavy oil, and only inject the heavy oil in small quantities just when it is needed. Of these oil injection engines two subdivisions may be distinguished:

(1) Hot chamber or shield vaporizing type.

(2) Mechanically atomizing type.

The former has for its purpose heat application so graduated as to just vaporize the fuel for ready mixture with the compression charge of air. The latter has for its purpose a purely mechanical spray or atomizing action upon the fuel, to break it up into the minutest globules and to surround it so closely by highly compressed and thereby heated air that a rapid combustion takes place. Of these subdivisions of the combustive method the latter, atomizing type, is the most promising, and of it the most efficient and best-known representative is the Diesel engine. While not yet largely introduced in marine practice, it is gaining ground steadily, and is making a remarkable showing in stationary practice, due to an unparalleled economy—about 50 percent better than the best gas or gasoline (petrol) engines of the explosive method. This is done with the cheapest grades of crude or fuel oil, such as can be bought nearly everywhere for 2 to 5 cents (1 to 2½d.) per gallon. It compares, therefore, in fuel costs, very favorably with a gasoline (petrol) engine. The possibility is that engines operated on the combustive method of fuel consumption are the coming type for marine propulsion, as they can operate with fuels that can be obtained cheaply and in large quantities in all the principal ports of the Atlantic and Pacific coasts of North America. The experience on the Pacific Coast, where heavy oils are now extensively used as fuel under steam boilers, has proved conclusively that these oils can be safely handled and stored upon commercial ships of all sizes. They avoid, therefore, the severe insurance and supervision restrictions that the underwriters and government inspectors place upon the storing of light oils, like gasoline (petrol).

The Diesel engine draws in only pure air, which it compresses to a pressure of about 525 pounds per square inch, and thereby imparts a great deal of heat to the compressed air; in fact, it gives the air charged so high a temperature that the crude oil, or fuel oil, when gradually sprayed into this red-hot compressed air, begins to burn immediately without any special ignition apparatus. It will be seen that a pronounced simplification of the machinery takes place in this absence of any ignition apparatus. This simplification is highly desirable, as in the generally damp and salty atmosphere of marine surroundings the ignition apparatus has always proved a source of great annoyance and unreliability. It has been found that the spraying of the oil charged into the cylinder at the commencement of the combustion stroke against the high pressure of 525 pounds of compression is best done by compressed air of about 800 to 1,000 pounds pressure per square inch. This breaks up the oil into very small globules mixed already with air and ready for an immediate ignition and combustion. This, of course, involves the installation of a high-pressure air compressor for the continuous supply of the needed injection air which might appear as a complication and burdensome addition to the power plant. The history of the marine steam engine proves, however, that the addition of auxiliaries tends to enhance economy and handiness, even if involving an increased first cost and labor of attendance. The addition of an air compressor to an internal combustion engine for marine propulsion can be considered only as an advantage because compressed air, stored in suitable receptacles, can furnish also the medium for readily reversing the main engine as well as for operating all the auxiliaries that are now in use on board of any vessel. The Diesel engine, of the modern stationary type, employs most successfully its injection air supply for the starting of large units in which cranking by hand would, of course, be entirely out of question.

Reversibility of the high order of the modern marine steam engine is dependent upon two factors:

(1) An automatic valve-gear that, upon simple operation of a hand lever, will make the direct-connected engine go immediately and continuously in the desired direction.

(2) A power impulse which, under the direction of the automatic valve-gear, can start the engine from any position into the desired direction of rotation immediately and without any other outside source of power.

In the internal combustion engine, as at present employed for marine service, very few builders have attempted to fulfill the two above-mentioned conditions. Most of them have been satisfied to solve the problem of reversibility by installing an engine that is kept continuously rotating in one direction and by connecting the engine to the propeller shaft by a mechanical reversible clutch with exchangeable, toothed or friction gearing. Another method is to connect the engine capable of rotating in one direction only with a propeller that is fitted with feathering blades. Both of these methods are suitable only for small boats and powers. Still another method which has been tried in Europe in a few cases is the connection of one or more Diesel engines of the stationary type rotating in one direction only to one or more dynamos and transmitting the electric current by way of the navigating bridge to reversible electric motors on one or more independent short propeller-shafts, fitted with ordinary propellers, but as can readily be imagined, the cost and weight of this electric transmission plan are high, and this fact will probably deter most owners of ships from installing it. A modification of this electric transmission system connects the Diesel engine to the propeller in such a manner as will enable direct drive for ahead motion, but uses a comparatively small dynamo at the engine going ahead to drive an electric motor upon the disconnected propeller shaft for backing motion.

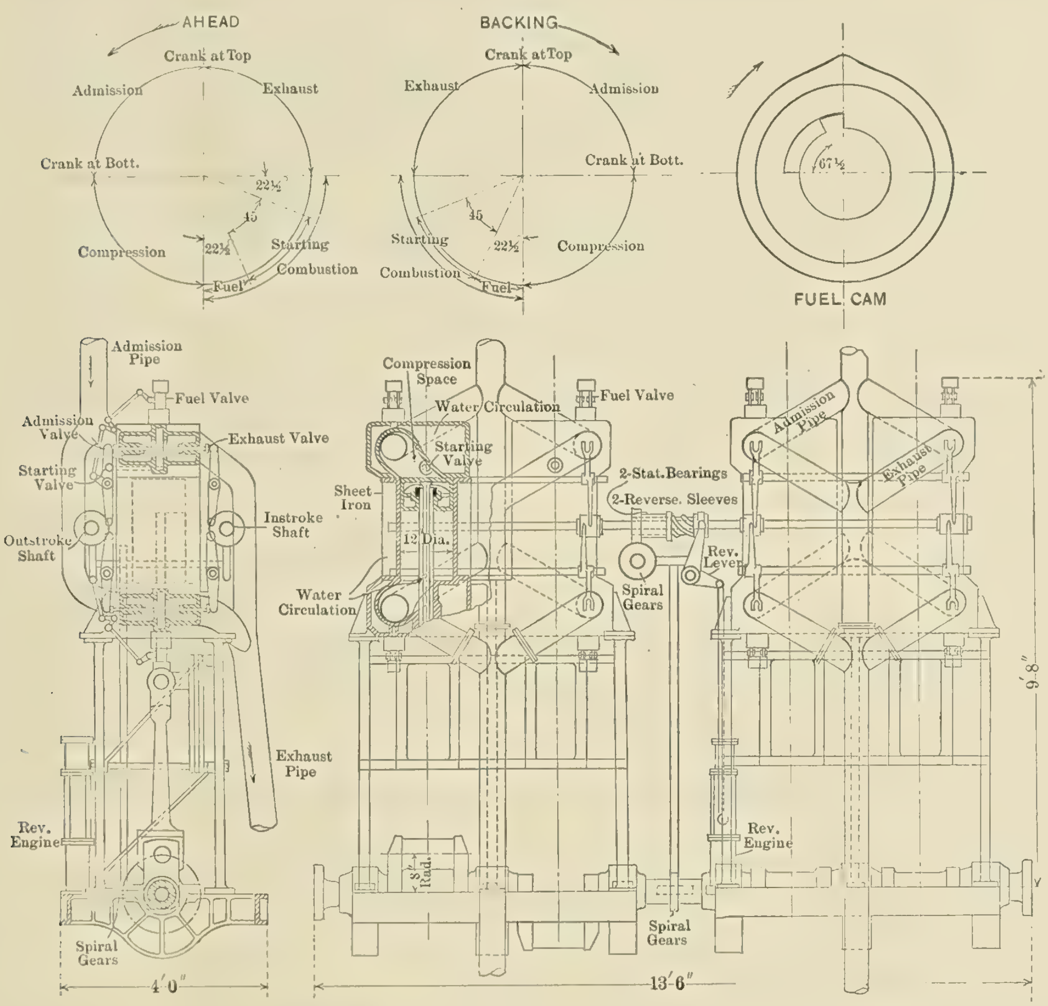


FIG. 1.—DESIGN OF A FOUR-CYLINDER, FOUR-CYCLE MARINE DIESEL ENGINE

The solution of the question of reversibility lies doubtlessly in the same direction in which the modern marine steam engine has made so great a success. This means for the internal combustion engine suitable for all classes of ships as a propelling agent an automatic reversible valve gear and an always ready and available impulse medium for which compressed air seems to be the most suitable. Regarding the first factor of reversibility, it has often been contended that the four-cycle internal combustion engine, of which the valve shaft runs at only one-half the number of revolutions of the crankshaft, cannot be fitted with automatic reversing gear. This opinion is erroneous, but a variation has to be introduced by making the reversing arc of the cams only 90 degrees. An additional complication is that some of the valve-gear members have to be advanced 90 degrees, while others have to be turned back 90 degrees to secure such conditions as will automatically and continuously rotate the engine in the new direction. These difficulties, however, can, by thorough study and analysis, be satisfactorily overcome in more than one way.

Fig. 1 shows a four-cylinder, four-cycle marine engine of the Diesel type, operated by revolving cam-shafts, cams and poppet valves, as usually fitted to internal combustion engines. In this case the valve members have been divided into two groups of

(1) Instroke members, comprising all the exhaust valves.

(2) Outstroke members, comprising all admission, fuel and starting valves.

As all members of the same group move for reversing in the same direction it seemed best for practical construction purposes to give one strong shaft to each group and reversing all cams with the shaft. It is thus possible to fit for each shaft a powerful reversing sleeve of the type frequently employed in high-powered yacht engines. These sleeves can be conveniently operated by a reversing engine, as shown in Fig. 1, which may be operated by compressed air and fitted with an oil cylinder, to prevent dancing and vibrating of the valve gear.

The diagrams of Fig. 1 show how the different cams have to be set and how they have to move with their respective shafts to secure an automatic and prompt reversal. As the fuel cam has to move through an arc of only 22½ degrees its cam may be fitted as shown, sliding on its shaft in the manner of the loose eccentrics used in the old-style paddle-wheel engines. By making the boss and the feather long no difficulty of excessive wear need result from this construction.

Other four-cycle engine arrangements without sleeve reversing and cams, necessarily heavy for large engines, may solve the problem by providing, instead of revolving cams, swinging levers in a manner similar to our familiar beam engines. These levers may be operated from a regular link-gear with the usual marine reversing engine, rock shaft and adjustable rock-shaft levers, by which the fuel valve cut-off can be regulated while running. For two-cycle engines the special valve shafts are avoided and a regular link-gear can be fitted directly to the crank-shaft. One form convenient for two-cycle oil engines of the Diesel type employs a Pius Fink link which, in simple arrangement, needs only one eccentric, and is well adapted to the large angular advance and the short cut-off of the fuel valve, never exceeding 10 percent.

Fig. 2 illustrates a two-cycle double-acting engine, in which a Marshall type reversible valve gear is employed to work scavenging air-admission, fuel injection and starting valves. The two latter are so connected that the one is out of action when the other is working. A further improvement shown in Fig. 2 is positive control of all poppet valves without springs, thereby avoiding looseness, noise and motion in a seaway. The whole engine will be found resembling quite strongly the normal marine steam engine.

The second point of efficient reversibility is a ready power impulse that can start the engine from any possible position immediately and powerfully in the new direction of rotation. This should take place in the same manner as live steam from the boiler starts the marine steam engine, upon opening of the throttle. The power impulse should be powerful enough to overcome all frictional resistances of the engine and of the shafting with propeller, as well as of compression-pressures in the engine. With six or four cylinders there can always be one cylinder receiving starting air with its crank under a favorable starting angle, so that the engine will readily start from any position. Great economy is needed with the starting air, as it takes considerable power to provide compressed air of high pressure and the cylinders with their large volumes are powerful consumers of the air.

The opening of the starting valves must be automatic with the operation and running of the engine, while being at the same time under the control of the engineer for their immediate throwing in or cutting out. The style of floating lever, as employed for the automatic operation of the reversing engine, is well adapted to perform the operation of the starting valve with automatic and manual control. The same hand-

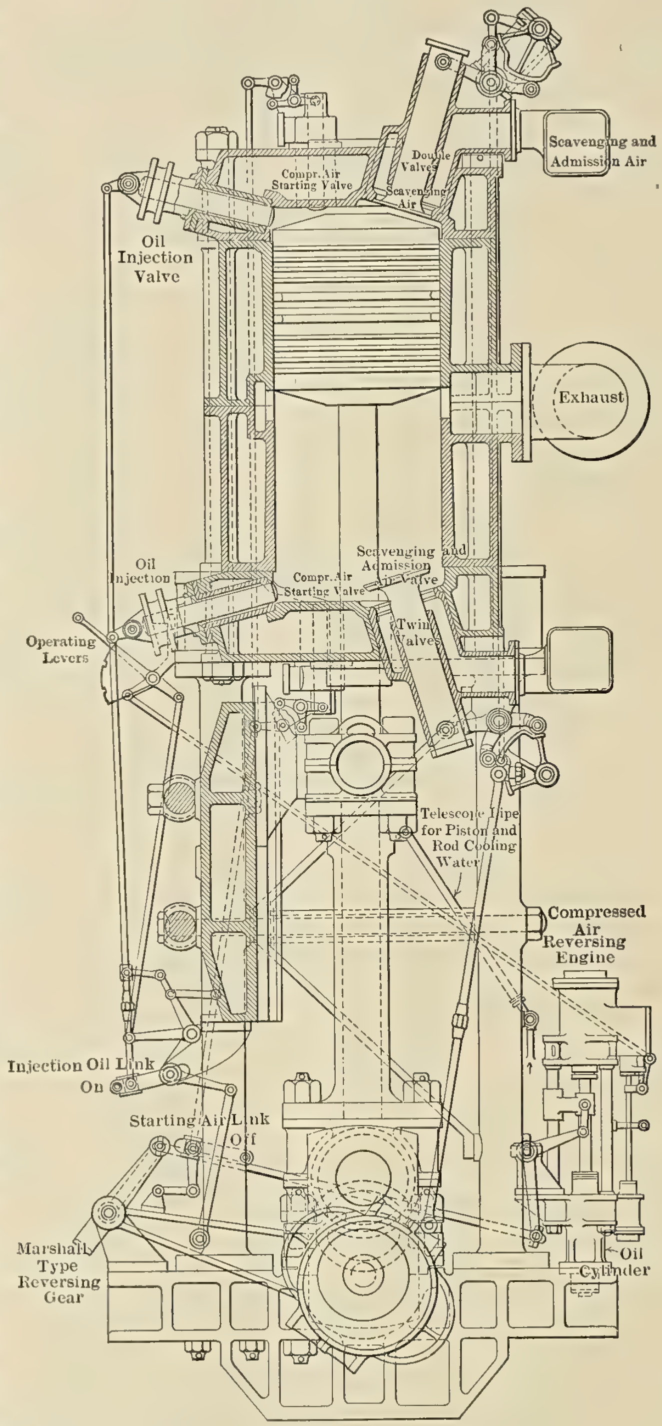


FIG. 2.—TWO-CYCLE, DOUBLE-ACTING OIL ENGINE

lever that the engineer employs for control of starting valves can in its opposite swing be employed for opening and shutting of oil valves which may be used to regulate the admission of the oil into the fuel valves. The engine of Fig. 2 shows an arrangement in which the same hand-lever actuates the connecting rods of the starting valves, as well as of the fuel valves, the one being completely shut off when the other one is on. With such arrangements an internal combustion engine of the Diesel type may be considered equal to a steam engine, as far as handiness and reversibility are concerned.

The question of increased or reduced powers will yet have to be considered. An internal combustion engine of any type is inferior to a steam engine as regards overload. A steam engine can always be urged to a little larger exertion by increased pressure or later cut-off, while an internal combustion engine cannot consume any fuel in excess of that which can be burned by the available oxygen of the admission charge. But an oil engine of the Diesel type is superior to a steam engine as far as reduced power goes, because it keeps its economy much better at low powers than is possible for a steam engine. The reducing of the power is done at the fuel pumps that supply the oil in liquid state to the fuel valves. By keeping the bypass or suction valves open during a longer or shorter part of the stroke of the fuel pump plungers a larger or smaller amount of oil in very accurate regulation is delivered to the valve. The usual eccentric mechanism that acts upon the valves is, in stationary installations, operated by the governor, while in marine installations a special handlever can be arranged at the engineer's platform. An engineer operating such a Diesel marine oil engine would have at his platform almost exactly the same working levers as a steam engineer has. He would have an air and oil lever corresponding to the steam throttle valve lever, also a reversing engine lever in the same form as the engineer of a steam engine has, and lastly an oil pump regulating lever corresponding to the engine-room stop-valve wheel for the purpose of running the engine under reduced powers. For large engines, as illustrated by Fig. 2, additional levers and gear could be provided at the engineer's platform for a ready control of butterfly valves in the ducts leading from the scavenger blowers. Control may also be had of valves in the admission pipes, from the cooling water pumps to the cylinders, cylinder covers, pistons and piston rods, until all the overflows show steady stream and uniform temperature.

The crude oil does not offer a very convenient and clean medium for power distribution to all kinds of auxiliaries, and this drawback necessitates for most cases the fitting of a sort of central station in connection with the main engines. Small oil engines of highly economical type could there be employed to transfer their energy to either electricity or compressed air or perhaps to a combination of these two agents. As it is necessary to have compressed air for oil injection and for starting purposes it seemingly offers a convenient way of operating all auxiliaries.

As is well known, compressed air can be used exactly like steam in all small rotating engines now used on board ships, as well as in all reciprocating, direct-acting pumps. By employing compressed air from a central power station the same auxiliary engines or auxiliaries which the steam engineer or oiler is in the habit of operating now may be used, perhaps retaining in a change of motive power for an old ship all the same auxiliaries, but without the disadvantages of heat and dripping condensed water and with the advantage of a fine, cold air ventilation. Compressed air may also prove of advantage on board ship by its application to calking, chipping and boring tools for wood and iron in repairs and alterations as frequently required on board of large passenger or cargo vessels.

To get maximum economy and convenience out of the low-pressure air transmission to the auxiliaries, reheating of the air may readily be obtained, either in special oil heaters or by the hot exhaust gases from the compressor engines. This would do away with freezing at the small engines, while greatly increasing the economy of the power transmission. The application of compressed air to auxiliaries from a central source is the more profitable, the larger the ship and the larger the whole machinery plant.

A machinery plant with Diesel oil engines is pre-eminently fitted for large vessels of commercial as well as naval service. In such vessels one might apply the compressed air to driving the reversing engine, the turning engine, all the cooling water pumps of the main propelling engine and of the air-compressor. Further, there can be driven the fire pumps, the bilge pumps, the water bottom pumps and the sanitary hot, cold, fresh or salt water pumps. Then there can be driven the dynamos, the ice machine, the steeering engine, the winches, the windlass, and, for naval vessels, the ammunition hoists and turret-turning gears. It can readily serve in purely reciprocating apparatus such as pumps, hoists, lifts, as well as in crank movement apparatus like winches, windlass, steering engine, etc. An advantage is also that its control may be local or from a distance, like locations in the pilot house, controlling a steering engine, or on a gunsighting platform in a turret controlling the turning or ammunition hoist-engines.

In the light of the development of the steam turbine of the last few years, a compressed-air turbine of good economy, perhaps multistage, might prove quite feasible and practical for driving purely rotating apparatus like fans, high- and low-pressure centrifugal pumps, dynamos, electrical boosters or rotary transformers, if such might be required.

An advantage of the compressed air is that its engines can be arranged without any discomfort under protective decks and in armored spaces with little ventilation. The ventilation of many spaces can conveniently be arranged by compressed air without special engines or fans. The use of compressed air for auxiliaries contributes most materially to the habitability of the ship and the comfort of the crew. By using the high-pressure only for oil injection in close proximity to the last stage of the compressors very little piping need be exposed to the high pressure.

For operating the auxiliaries, it would not be advisable to employ the air at 800 to 1,000 pounds pressure, as required for injection purposes; but, as the injection air has to be obtained in multistage compression, it is well, possibly, to provide tanks for storing air at an intermediate stage, say 125 to 150 pounds, and use this air for starting at relatively late cut-offs, as well as for operating auxiliaries. By making the first two cylinders of the air-compressors extra large the extra supply of medium-pressure air for the auxiliaries can readily be obtained without further complication and stored in special medium-pressure receivers of relatively large capacity. These resemble in their power-storing capacity the boilers of the steam installation, as being always ready for service in starting main engines and in operating auxiliaries, and with considerable less attention than boilers require. Electricity will probably always be demanded for lighting purposes and wherever else it would seem to offer special advantages. In the central power station the driving engines for generator sets would be similar to the main engines, except being single-acting of the stationary, governor-controlled type. As found with steam auxiliaries on board ship subdivision into interchangeable units proves handiest. In this light, it might seem best to arrange for several multistage air compressors with extra large low-pressure cylinders and directly connected to double cylinder oil engines. As the whole operation of the main engines and auxiliaries depends upon the presence of available compressed air, several interchangeable compressor units, each nearly powerful enough for maximum requirements, would seem the safest outfit to adopt.

The tremendous improvement in fuel economy of oil engines of the highest type, the great saving in space and in weight and the consequent increase in earning capacity of the ship over a corresponding steam engine of reciprocating or even turbine type, is bound to be recognized by the marine world before long.

In the United States, where there is an abundant fuel supply, the situation is especially favorable to the installation of oil engines.

Recent Developments in Oil Fuel Burning*

BY E. H. PEABODY

Idalia Experiments

Having completed preliminary experiments with the atomizers in connection with a fire-brick oven built for the purpose and entirely separate from a boiler, the apparatus was removed to the Babcock & Wilcox Company's dock at Bayonne, N. J., where the steam yacht *Idalia* was moored preparatory to being laid up for the season. This vessel is fitted with a Babcock & Wilcox marine boiler containing 2,560 square feet of heating surface and 340 square feet of superheating surface. A simple and effective system of induced draft fans is installed capable of giving a suction in the uptake of 1 to 1¼ inches of water, and in addition to this a forced draft fan was set up on the dock and connected by means of a flexible duct to a sheet steel casing enclosing the oil burners on the front of the boiler. The tanks and scales for weighing the oil and water, and the oil pump and heater, were set up on the dock and connected with the vessel by means of flexible pipes, the regular feed pump of the plant being used taking weighed water from the filter box. The engine and other auxiliaries were not in use, the steam being discharged to the atmosphere through a muffler so arranged, however, as to maintain regular working pressures on the boiler. All precautions were taken to prevent leaks and secure accurate data.

The object of these tests was to burn oil with mechanical atomizers, to burn as much oil as possible without smoke, and to secure the best possible evaporation per pound of oil.

Fifteen evaporative tests were made under a variety of conditions. In between these tests considerable experimenting was done with various air-distributing arrangements, flat-flame burners, etc. The best performance was an evaporation of 7.47 pounds of water per square foot of heating surface per hour from and at 212 degrees at an efficiency of 82.8 per cent at a rate of combustion of 6.17 pounds of oil per cubic foot of furnace volume per hour, with a draft in the uptake of .84 inch of water. The air in this test was admitted to the furnace through what we call an impeller plate, Fig. 12. Beginning with the cast iron cone with air slots on the side as shown in Fig. 10, various other air distributors were tried, but none of these seemed to promise as well as the impeller, either as to smokelessness, gas analysis, ignition of the oil, or noise.

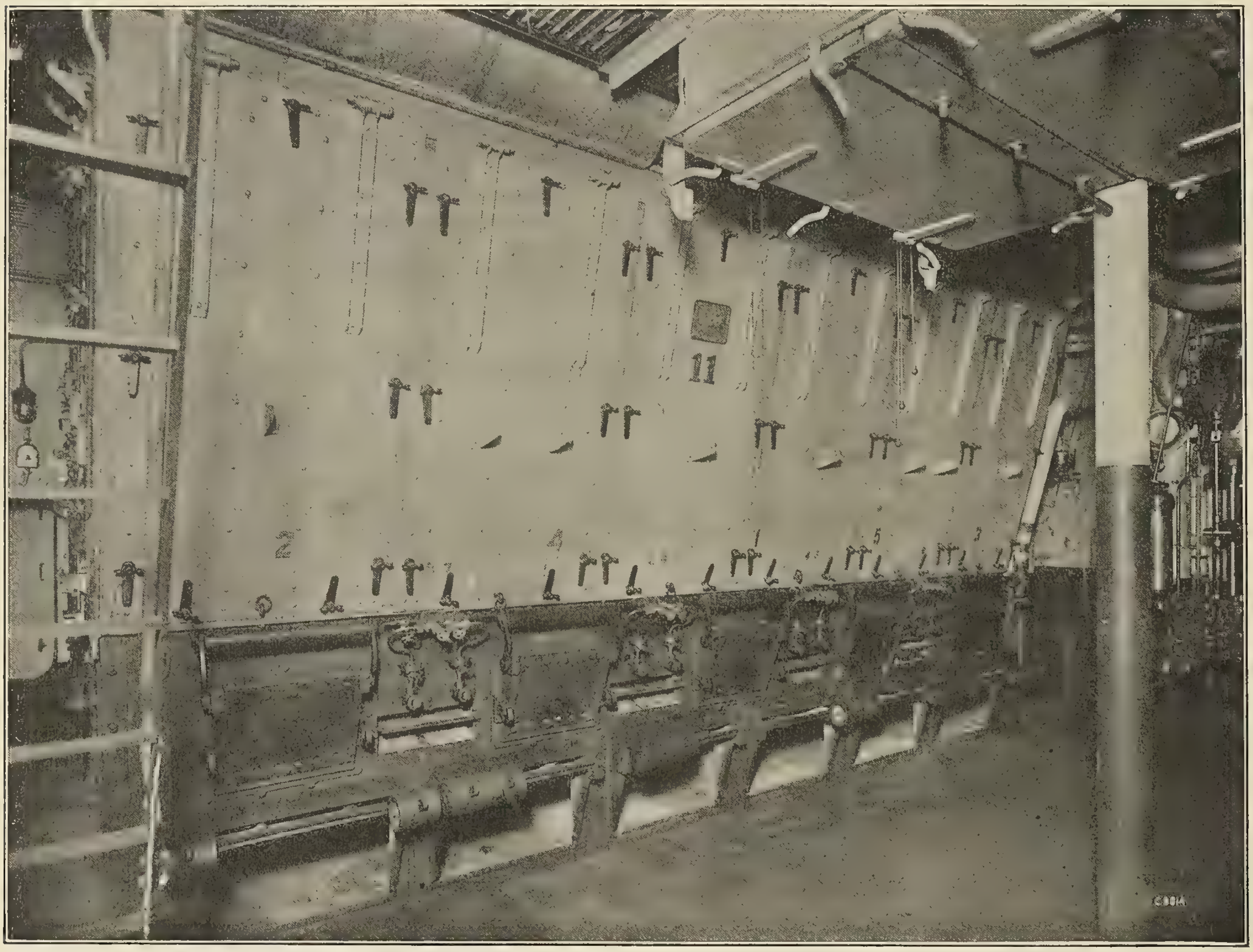


FIG. 11.—BABCOCK & WILCOX BOILER, U. S. S. WYOMING, SHOWING OIL BURNERS IN COMBINATION WITH COAL

Wyoming Tests

Coal.—The contracts for the United States battleships *Wyoming* and *Arkansas* called for a series of four 24-hour guarantee tests with coal, the first to be at a rate of combustion of 15 pounds, the second at 25 pounds, the third at 35 pounds, and the last at 40 pounds of coal per square foot of

* Continued from the January issue.

grate surface per hour. The idea was to duplicate a possible severe war condition, and it was required that the evaporation per pound of combustible in the final test should not be less than 11 pounds of water from and at 212 degrees. This requirement was increased to 11½ pounds for the next contract after obtaining the excellent results in the tests on the *Wyoming* boiler.

As both the U. S. S. *Wyoming* and the U. S. S. *Arkansas* were fitted with Babcock & Wilcox boilers, and as both these ships were to burn oil in combination with coal, it was decided to build a special test boiler of exactly the same design and proportions, except that it was not as wide, set this up at the works, with an air-tight house around it, force air into this house under pressure to duplicate the conditions of a closed fire room on board ship, and after making the guarantee tests with coal continue the experiments with oil, and with oil and coal in combination. This plan proving acceptable to the Engineer-in-Chief of the Navy, the boiler was built and tested under guarantee conditions by a board of naval officers, of which Captain C. W. Dyson was the senior member.

As this same boiler was later tested with oil fuel, the comparison with coal is of general interest, and I have therefore copied the results of the coal tests from the Board's reports (Table I). It will be noticed that a fifth test was made at the high rate of combustion of practically 70 pounds of coal per square foot of grate per hour. This was not part of the guarantee, but was made at the request of the builders to show the possibilities of forcing the boiler. In this test, 14.76 pounds of water were evaporated from and at 212 degrees per hour per square foot of heating surface.

Preliminary Tests with Oil Fuel.—After the completion of the coal tests the boiler was thoroughly cleaned of soot and ashes, fire-bricks were laid on the grate bars, and the front was arranged to receive the oil burners and air-distributing device.

While the results of the *Idalia* experiments had been promising it was desired to materially increase the capacity, .45 pound of oil per square foot of heating surface and about 6.2 pounds per cubic foot of furnace volume having been the maximum in those tests. In this we were assisted by the fact of having available a strong closed fire-room draft and a powerful steam jet in the stack. Much experimenting was, however, found necessary, almost entirely in the direction of air admission and distribution, some two months being devoted to preliminary trials of various forms of apparatus.

TABLE I.—WYOMING. OFFICIAL TESTS WITH COAL

Babcock & Wilcox boiler, 2,571 square feeet H. S., G. S. 57.3; ratio, 44.4 to 1; Pocahontas, hand-picked coal

Date of test, 1910.	June 13–14.	June 14–15.	June 15–16.	June 16–17.	June 18.
Duration of test (hrs.)	24.06	24.5	24.0	24.0	3.0
Steam pressure (lbs.)	202	201.4	202.8	201.6	200.4
Temperature feed water (°F.)	211.6	211.4	207.8	204.1	194.4
Moisture in steam (p. ct.)	0	0	.086	.172	.43
Moisture in coal (p. ct.)	.88	.74	.74	1.06	.75
Dry coal burned per hour (lbs.)	873	1,425	2,039	2,379	4,036
Per cent refuse in dry coal by test	6.0	3.83	3.28	4.34	8.55
Dry coal burned per square foot of grate per hour	15.08	24.62	35.22	41.10	69.72
Draft in uptake (in.)	−.31	−.94	− .30	− .26	—
Draft in furnace (in.)	−.16	−.46	+ .66	+ .91	—
Air pressure in fire-room (in.)	.00	.00	+1.41	+1.95	+3.00
Temperature air entering ash pit (°F)	94	98	86	94	106
Temperature waste gases (°F.)	491	545	602	628	659
Analysis of waste gases (p. ct.) CO_2	13.2	13.6	12.9	13.6	11.6
Analysis of waste gases (p. ct.) CO	4.2	4.7	4.5	3.9	5.07
Analysis of waste gases (p. ct.) O	0.5	0.4	0.5	0.8	1.09
Analysis of waste gases (p. ct.) N	82.1	81.3	82.1	81.7	82.24
Water evaporation into dry steam per hour from and at 212° (lbs.)	9,974	16.543	23,208	27,060	37,951
Water per square foot heating surface per hour from and at 212° (lbs.)	3.88	6.43	9.03	10.52	14.76
Water per pound dry coal from and at 212° (lbs.)	11.42	11.61	11.38	11.38	9.45
Water per pound combustion from and at 212° (lbs.)	12.15	12.07	11.77	11.89	10.33
Efficiency based on dry coal (p. ct.)	72.50	73.70	72.24	72.24	60.00
Heat balance in per cent, calorific value of combustible—					
Absorbed by boiler (p. ct.)	74.39	73.95	72.06	72.80	63.25
Loss due to heat in waste gases (p. ct.)	11.09	12.24	14.63	14.20	16.31
Loss due to moisture in fuel (p. ct.)	.07	.06	.06	.09	.07
Loss due to burning hydrogen (p. ct.)	3.27	3.34	3.44	3.45	3.46
Loss due to incomplete combustion (p. ct.)	2.09	1.61	2.15	3.18	4.98
Various other losses including radiation and unaccounted for (p. ct.)	9.08	8.80	7.66	6.28	11.93

Again the flat-bladed impeller plate was found to be most suitable, a number of different designs of this being tried out, among which may be mentioned one having adjustable blades. Finally, with the grate bars in place, six burners and impellers were installed, two in each fire door, and a test was made resulting in a combustion of .72 pound of oil per square foot of heating surface and 11.6 pounds per cubic foot of furnace volume, a very distinct advance over the *Idalia* performance.

The grate bars were then removed, the ash pan lined with fire brick, a second row of burners installed below the first, and efforts to obtain still higher capacities were continued. The experiments indicated that a considerable number of smaller burners and impeller plates was preferable to a few of larger size, and the furnace front was remodeled and fitted with eleven cast iron boxes 13 inches square, each carrying an impeller plate 8 inches in diameter and each arranged to receive a burner. With nine of these burners in operation an evaporization of 13.16 pounds of water per hour from and at 212 degrees per square foot of heating surface was obtained, burning .85 pound of oil per square foot.

The figures thus obtained seemed to warrant our requesting that a board of naval officers be appointed to witness and supervise further tests. There was no guarantee connected with the matter, but we were desirous of demonstrating to the Navy Department what could be done with our apparatus, and also particularly to have the results checked by competent and thoroughly disinterested observers who should secure sufficient authentic data to place the final figures absolutely above criticism. It seems unfortunate that this plan is not more frequently followed, as *ex parte* tests are always open to doubt, especially when the results are unusual.

Official Tests with Oil Fuel.—The following extract is from the beginning of the Board's report:

"This test was conducted by a Board composed of Captain C. A. Carr, U. S. N., and Lieutenant-Commanders J. K. Robinson and John Halligan, Jr., U. S. N.

"The Board assembled at the works of the Babcock & Wilcox Company, Bayonne, N. J., about 10 A. M., Nov. 28, 1910. The Board examined the test boiler and its connections for water and steam tightness, the arrangements for measuring water and oil and the apparatus for taking data. All of these were found satisfactory, and the tests were proceeded with at once. In all these tests oil was used as a fuel.

"Civilian assistants from the office of the Inspector of Machinery, Bayonne, N. J., were detailed for the purpose of tak-

TABLE II.—WYOMING. OFFICIAL TESTS WITH OIL

Babcock & Wilcox boiler, 2,571 square feet heating surface; Peabody mechanical atomizers; Texas oil—lighter constituents removed

Date of test, 1910.	Nov. 28.	Nov. 28.	Nov. 29.	Nov. 29.	Nov. 30.	Dec. 3.
Duration of test (hrs.)	2	3	3	4	3	3
Steam pressure (lbs.)	210	210	211	212	215	215
Temperature of feed water (°F.)	168.6	160.9	201	211.2	185.6	182.8
Moisture in steam (p. ct.)	.81	.71	.16	.11	.22	.17
Pressure of oil at burners (lbs.)	191	189	176	131	153	172
Temperature of oil at burners (°F.)	175	183	184	210	199	196
Oil burned per hour (lbs.)	2,972	1,704	1,202	666	1,922	1,947
Oil burned per burner per hour (lbs.)	270.2	213	300.5	222	240.3	243.4
Oil burned per cubic foot furnace volume per hour (lbs.)	13.69	7.85	5.54	3.07	8.86	8.97
Oil burned per square foot heating surface per hour (lbs.)	1.156	.663	.467	.259	.747	.757
Draft in uptake—referred to atmosphere (in.)	−2.23	−.41	−.46	−.39	− .61	−1.15
Draft in furnace—referred to atmosphere (in.)	—	—	—	−.32	+ .32	− 0.01
Air pressure in fire-room—referred to atmosphere (in.)	+2.60	+1.69	+1.18	+.33	+1.97	+1.64
Temperature of air in fire-room (°F.)	71	75	70	79	79	76
Temperature of waste gases (°F.)	771	666	533	447	702	630
Analysis of waste gases (p. ct.) CO_2	9.85	9.26	11.57	11.86	10.71	10.94
Analysis of waste gases (p. ct.) O	6.46	7.68	4.50	4.08	5.18	4.73
Analysis of waste gases (p. ct.) CO	.01	.00	.04	.04	.02	.00
Analysis of waste gases (p. ct.) N	83.68	83.06	83.89	84.02	84.09	84.37
Water evaporated per hour from and at 212° (lbs.)	40,712	24,494	18,895	10,569	27,149	30,064
Water evaporated per square foot heating surface per hour from and at 212° (lbs.)	15.83	9.53	7.35	4.11	10.56	11.69
Water evaporated per pound of oil from and at 212° (lbs.)	13.70	14.37	15.72	15.86	14.12	15.44
Specific gravity of oil	.932	.932	.932	.932	.932	.932
Flash point of oil (°F.)	295	295	295	295	295	295
British thermal units per pound of oil	19,291	19,291	19,291	19,291	19,086	19,086
Efficiency (p. ct.)	69.29	72.68	79.50	80.21	71.41	78.08
Number of burners in operation	11	8	4	3	8	8
Smoke on scale of 5	2.1	1.5	1.3	1.5	2.3	1.15

ing data. Another set of observers was furnished by the Babcock & Wilcox Company, who took data independently. The data taken by the two sets of observers were compared, so that any errors in reading were corrected at once."

The report concludes as follows:

"The Board was particularly impressed with the excellent

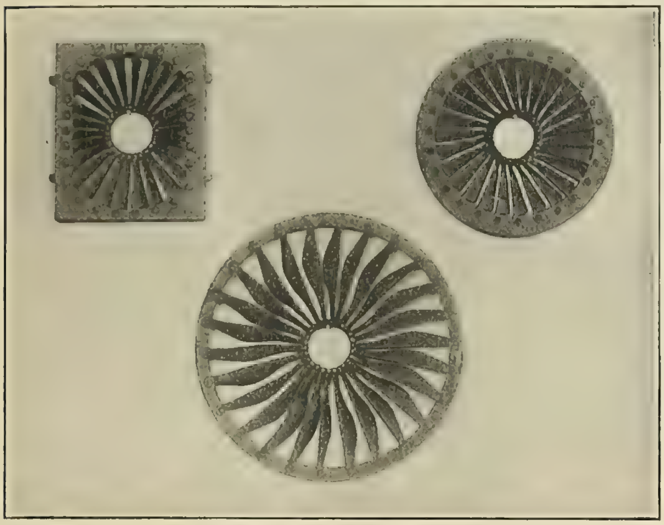


FIG. 12.—IMPELLER PLATES

results obtained with this boiler under the maximum rate of combustion, Test No. 1, which gives a combustion of 13.69 pounds of oil per cubic foot of furnace volume. This is the equivalent of about 75.34 pounds of coal per square foot of grate area in the same boiler when burning coal. The boiler in this test steamed freely with a very slight increase in the wetness of steam, and the falling off of efficiency was small for a rate of combustion much above the maximum ordinarily used on boilers of the Navy under forced-draft conditions.

"After all the tests were completed the boiler was opened, cleaned and thoroughly inspected for deterioration. No tubes

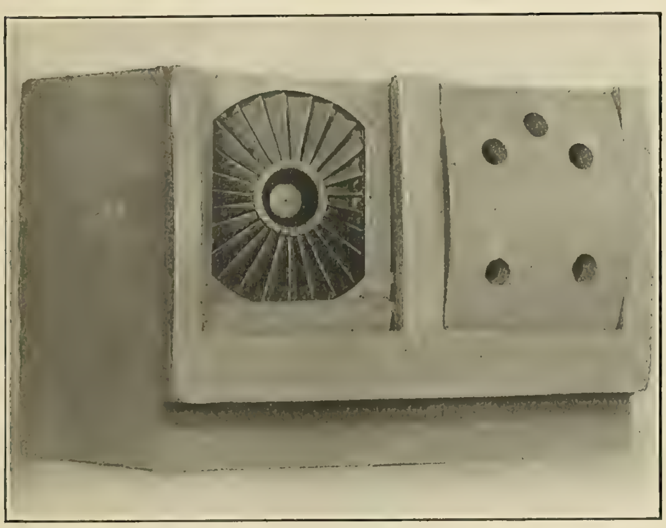


FIG. 13.—FITTING OF OIL BURNERS FOR COAL AND OIL, REAR VIEW

showed any signs of distortion, and all tubes and headers were free of blisters. All baffles were in good condition and properly placed."

It may be interesting to note that the wetness of steam referred to in the Board's report did not exceed as a maximum 81 hundredths of 1 percent, as shown in the results of the tests which are given in Table II.

Oil and Coal in Combination.—The writer does not believe that two such different fuels as coal and oil can be burned in the same furnace at the same time with results in efficiency equal to those which can be obtained with either fuel alone. The problem, always difficult, of securing complete combustion of the volatile hydrocarbon becomes more difficult, and one fuel inevitably interferes with the other. The injection

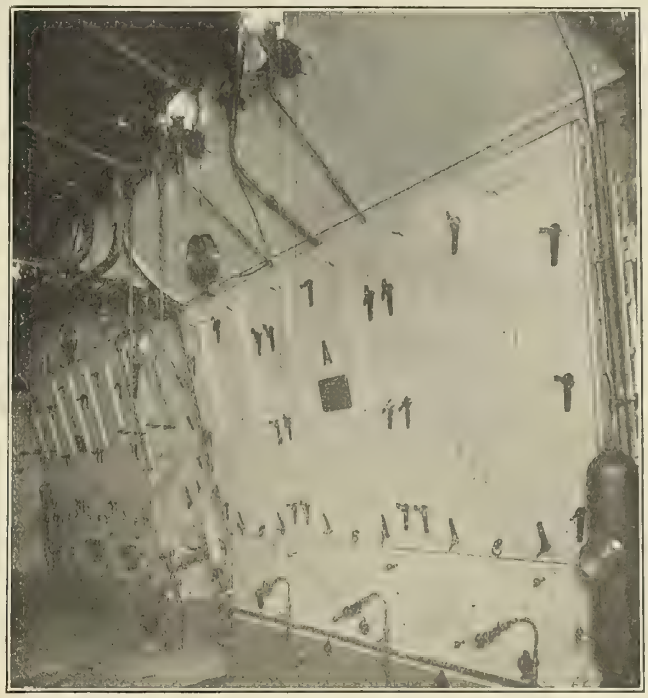


FIG. 14.—U. S. S. ARETHUSIA, FUEL OIL SYSTEM

of an oil spray over a coal fire is, however, a most effective way of boosting up the capacity of the boiler, and for this purpose the combination has a wide field.

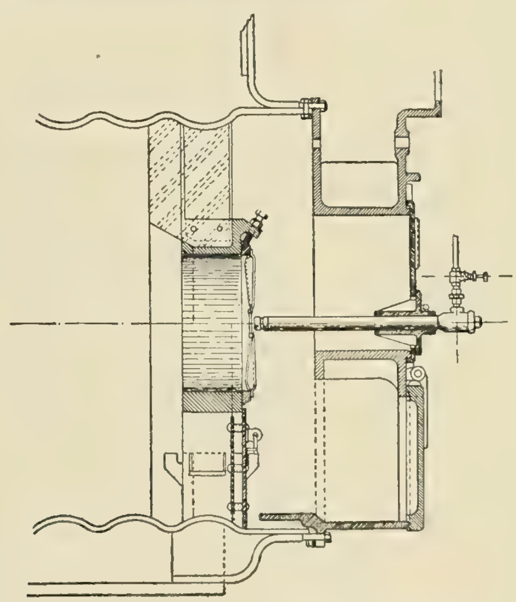


FIG. 15.—HERMAN FRASCH INSTALLATION

As noted above, the United States battleships *Wyoming* and *Arkansas* were to burn coal and oil in combination. Consequently, after completing the oil tests we turned our attention to the best method of getting the two fuels to work together. Obviously the most satisfactory location for the burners is between the fire doors. But owing to the fact that the ash pan, grate bars, and bed of coal and clinker on the grates combine to take up considerable space, there is bound to be a somewhat limited head room in the furnace. For this purpose the flat spray burner is well adapted, but the flat spray mechanical atomizer, as so far developed, does not at satisfactory capacities give as fine a spray as the round or conical spray atomizer. It is, however, possible, as we have found by experiment, to alter the shape of the flame from the round flame burner by manipulating the air for combustion. Thus, if the air be admitted through a horizontal slot, the flame will be diminished in width and increased in height, and, vice versa, if the air be admitted through a vertical slot the flame will be spread out sideways and decreased in height. The latter effect is what is desired in the combination of coal and oil. Consequently, while still retaining the whirling motion of the air, which we have found effective, we modified the impeller plate to approach the vertical slot idea, and in this way we were able to broaden out the oil flame over the coal bed so as to burn .6 pound of oil per square foot of heating surface per hour in combination with a rate of combustion of 25 pounds of coal per hour per square foot of grate surface. This device is shown in Fig. 8 and Fig. 13. The space between the fire doors is occupied by a casting designed to carry two impellers side by side, each of an oval form as indicated. This casting is air-cooled and is provided with slide ways so arranged as to permit of substantial cast iron shutters being pushed up in front of the impeller plates when the burners are not in operation, thus effectually shielding the impellers and the burners themselves from the radiant heat of the furnace. The burners and impellers therefore remain constantly in place while burning coal, and it is only necessary to put pressure on the oil line, slide the shutters down out of the way, and turn on the oil when the latter is needed.

Fig. 11 shows the front of one of the boilers of the United States battleship *Wyoming* as installed in the vessel.

If it is desired to operate with oil fuel only, the coal fire is allowed to go out, leaving the grate bars covered with ash and clinker to protect them from the heat, and the oil burners are lighted exactly as if no coal was used at all.

Natural Draft.—In the experiments described above forced draft had been available, and there is no doubt that the high velocity of the air thus secured is a material assistance in securing the proper mixture with the oil spray. It is often desirable, however, to run under natural draft conditions, particularly when the vessel is in port. For this reason a supplementary series of experiments was inaugurated for the purpose of adapting the apparatus to the requirements of lower draft pressures. The principal changes found necessary were a modification of the shape of the blading and an increase in size of the impeller plates.

The boiler room of the United States Navy oil-tank ship is shown in Fig. 14, the two Babcock & Wilcox boilers replacing two double end Scotch boilers. This vessel is one of the first fitted with mechanical atomizers operating under natural draft.

Scotch Boiler Installations

The round spray mechanical atomizer and impeller plate are well adapted for use in the corrugated furnaces of the Scotch boiler, and the Babcock & Wilcox Company has made installations for both natural draft and Howden forced-draft vessels fitted with this type of boiler. Fig. 15 shows the arrangement adopted for the steamer *Herman Frasch*, of the Union Sulphur Company, recently altered from coal to oil burning. This vessel is now developing an indicated horsepower on less than a pound of oil.

(*To be concluded.*)

Monthly Shipbuilding Returns.—The Bureau of Navigation reports seventy-eight sailing, steam and unrigged vessels of 17,418 gross tons built in the United States and officially numbered during the month of December.

Freight Handling at Steamship Terminals

One of the most important problems confronting steamship men at the present time is the direct transference of miscellaneous package freight from railroad cars or a warehouse at a steamship terminal directly to the hold of a steamship, or, vice versa, the transference of a ship's cargo directly from the hold to railroad cars or a warehouse on shore. The present method of relying largely on manual labor and rehandling for this work is recognized as one of the chief causes of high transportation rates.

An arrangement has been suggested by the Link Belt Company of Chicago involving the use of a telpher system applied in combination with an ordinary traveling gantry crane having a boom which is equipped with a telpher runway projecting out from the end of the dock over the hatch of the vessel. The plan shown in Fig. 2 gives a general idea of the arrangement of this system. Railroad tracks extend on each side of the warehouse and a telpher runway almost completely encircles the warehouse and is connected at one end of the building by switches with other runways inside the warehouse, thus forming an endless path for the telpher machines to travel on. The traveling booms, A and B, which extend out over the vessel's hatches, each carry U-shaped telpher runways provided with sliding switches which connect with the main line runway, so that the telphers can be shunted out on to the boom over the hatches of the vessel, thus completing a circuit which enables the telpher to transfer the package freight loaded on flat board carriers directly from the hold of the ship to any part of the warehouse or directly to the freight cars on the tracks. The gantry cranes, of course, can be moved along the dock so as to be placed directly opposite the hatch of the vessel. With this arrangement loading and unloading can be carried on simultaneously, and the time the vessel is held at the dock for its cargo is greatly reduced.

In the arrangement shown, the length of the path traveled by each telpher in completing the circuit is 2,200 feet, and the time required for it to hoist its load in the warehouse and travel entirely around the circuit and deposit its load in the hold of a vessel is about 7½ minutes. High speed hoists are installed on the telphers for rapidly raising and lowering the loads, and it is claimed that by this system a vessel can be loaded or unloaded at the rate of from 1,000 to 3,000 tons or more per day of ten hours. The cost of transferring freight from the holds of vessels to any part of the warehouse or railroad cars is stated to be from 3 cents (1½d.) to 6 cents (3d.) per ton, depending upon the unit load carried. This cost covers power and wages of the operator, but does not include the labor of loading or unloading the flat board carriers. It is evident that since all rehandling by the ship's winches and all trucking by hand is eliminated, the cost of handling freight is reduced to a minimum.

The telpher system is nothing new, and has been so frequently utilized in general warehouse installations that its application to steamship terminals can be accomplished with a good guarantee of the results which can be obtained. The installation illustrated in Fig. 1 was made by the Brown Hoisting Machinery Company, of Cleveland, Ohio, and illustrates the adaptability of the general telpherage system to general warehouse or steamship pier needs.

Lloyd's Shipbuilding Returns.—The returns compiled by Lloyd's Register of Shipping, which take into account only vessels the construction of which is actually begun, show that excluding warships there were 542 vessels of 1,970,065 gross tons under construction in the United Kingdom at the close of the quarter ended December 31. The tonnage now under construction is about 123,000 tons more than that which was in hand at the end of the last quarter, and exceeds by 451,000 tons the tonnage building in December, 1911.

FIG. 1.—BROWNHOIST TELPHER SYSTEM INSTALLED IN WAREHOUSE

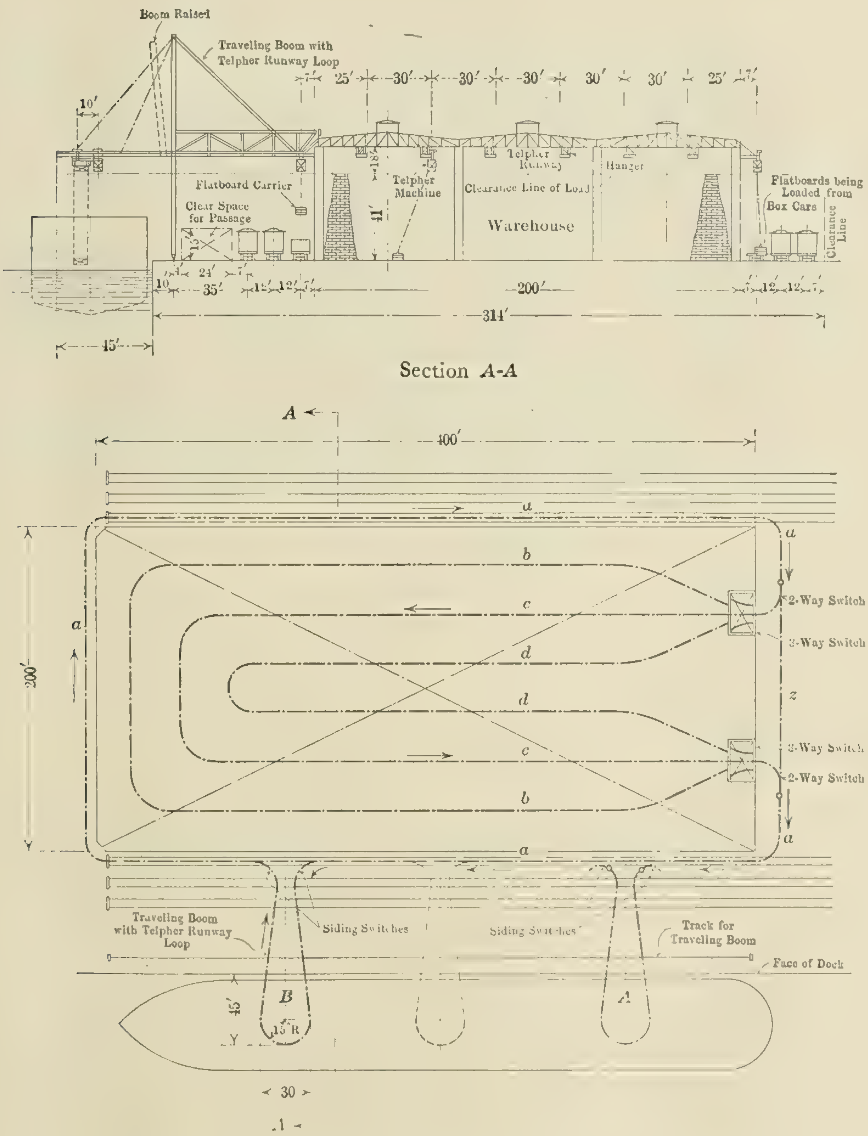


FIG. 2.—GENERAL ARRANGEMENT OF A TELPHERAGE SYSTEM ON A STEAMSHIP PIER

The American-Built Steam Yacht Lydonia

BY A. S. REED, JR.

This yacht is the second of two vessels of the same name built for William A. Lydon, of Chicago, by the Pusey & Jones Company, Wilmington, Del., and designed by William Gardner, of New York City. She is noteworthy as being the largest and finest full-powered steam yacht built and engined in the United States within the last ten years, and goes to show that Mr. Lydon's confidence in patronizing home industries has not been misplaced.

The contract for the vessel was received Feb. 20, 1911. She was launched July 25 of the same year. The contract was practically completed by Dec. 30, 1911, but she was compelled to stay in harbor at the builders' wharves on account of the heavy ice filling the Delaware River at that time. Her gross tonnage is 497, and in most cases her construction scantlings exceed Lloyd's and the American Bureau requirements. She will be used considerably on the Great Lakes and Atlantic seaboard, and has consequently been very strongly constructed. The principal dimensions are as follows:

Length over all	212 feet 6 inches.
Length on load waterline	170 feet 6 inches.
Beam, molded	26 feet 6 inches.
Depth, molded	16 feet 3 inches.
Draft, extreme	12 feet 6 inches.

The main deck is carried in a clear sweep from stern to within about 65 feet of the stem, whence it is continued forward by a forecastle deck at the height of the bulwarks forming a flush deck, and thus carrying out an unbroken sheer line, and affording increased freeboard and buoyancy forward. A continuous deck house is carried from within 60 feet of the stern to the break in the forecastle, in which are located the music room, library, engine and boiler casings, drying room, deck toilet, galley, pantry, deck storeroom, main dining saloon, paint locker, etc. These various rooms are all accessible by a continuous inside passageway on the starboard side of the ship, as is usual in modern practice. The upper or shade deck is carried from side to side of the vessel, allowing ample stowage for the boats carried and affording fine deck space. On the shade deck is located the chart house, which will also be used as a smoking room, and which is accessible from the main deck by a stairway. The ship will be navigated from the bridge on top of the smoking room, where are located binnacle, telegraphs, speaking tubes, steering column, etc., the deck being carried to the side in the shape of a flying bridge, supported from the shade deck.

The accommodations for owner, guests, officers, etc., are located on the lower or berth deck, and consist of ten staterooms and four bath rooms, including a large double stateroom aft, and not taking into account the officers' quarters, which consist of six staterooms and an additional bathroom. In the guest quarters is also fitted a large linen locker.

Hull Construction

The hull is constructed of mild open-hearth steel, and all material contributing to structural strength has been fully up to the United States standard for this class of work, the very best commercial practice governing all workmanship. The keel is formed of an 8-inch wrought iron bar, fitted in the longest possible lengths and carefully scarphed to the stem and stern frame, length of scarphs being about 21 inches.

The stem is a steel casting in two sections scarphed together 7 inches deep, of hollow section, sharp at the fore edge and carefully rabbited to receive the plating.

The stern frame is a forging in one piece, the propeller post being 8 inches deep and the rudder post 7½ inches, with lugs for rudder pintles and backing stops forged on and brass bushed. The rudder post is fastened to the transom floor by heavy angle-iron lugs.

The transverse frames are formed of steel angles, evenly spaced for the full length of the ship. They are doubled in way of all bulkheads. Heel pieces of the same size as the frames, 36 inches long, are fitted for three-fifths of the ship's length amidship. Four complete belt frames are fitted, two being located in the boiler space and two under the main engine. They are of angle and plate construction, with double reverse frames on the inboard edges.

Reverse frames are located on every frame, extending alternately to the main deck and the lower side stringer, except in the machinery space, where they are carried to the deck on all frames and double across the floors.

The floors are of heavy section steel plate, 22 inches deep at the center line. In the machinery space they are of increased depth to form suitable foundation for the engines, boilers, thrust bearings, etc.

The center keelson consists of heavy double angles riveted back to back, and carried continuously on top of the floors from end to end of the ship. A sister keelson is worked intercostally throughout the boiler and engine space, clipped to the floors and shell plating and fitted at the top with continuous double angles. In addition upper, lower and bilge stringers are carried as far forward and aft as possible, formed of double angles. All keelsons are carried continuous throughout the bulkheads and stapled watertight. Bilge, or rolling keels, are fitted amidships.

The main deck beams consist of channels fitted on every frame with a crown of 7 inches in 26 feet, and securely bracketed to the frames. The lower deck beams consist of angles on every frame, well bracketed to the frames and stanchioned to keelsons. Lower deck beams have no camber. Fore and afters, of beam scantlings, are fitted in way of all hatch openings. The shade deck beams are steel angles, closely spaced, fastened to the house shelf and tied on the ends with a continuous stringer plate.

The ship is sub-divided transversely by five watertight bulkheads and three non-watertight bulkheads extending from the keel to the main deck. The bulkhead plating is worked in horizontal strakes and stiffened by angles, spaced 22-inch centers, horizontally on one side and vertically on the other. The bunkers, which consist of one transverse and two side bunkers, are designed to stow 125 tons of coal, and are constructed substantially the same as other bulkheads, except that they are stiffened on one side only by vertical stiffeners and made dust proof.

The main deck stringer plate is 30 inches amidship, reduced to 20 inches at the ends and fastened to the sheer strake by a heavy angle. Tie plates are worked under the sill of the main house, and diagonal deck ties are fitted forward and aft; 12½-pound partner plates extending over three beam spaces are fitted at the mast, and extra foundation plates are fitted under the windlass and bitts. The main deck over the boilers is completely plated over with 6-pound plating, and 10-pound tie plates are worked in the way of all deck hatches and coaling scuttles. Four coaling scuttles are fitted for filling the bunkers on each side of the main deck, and the latest improved watertight covers are provided and supplied with coaling hopper.

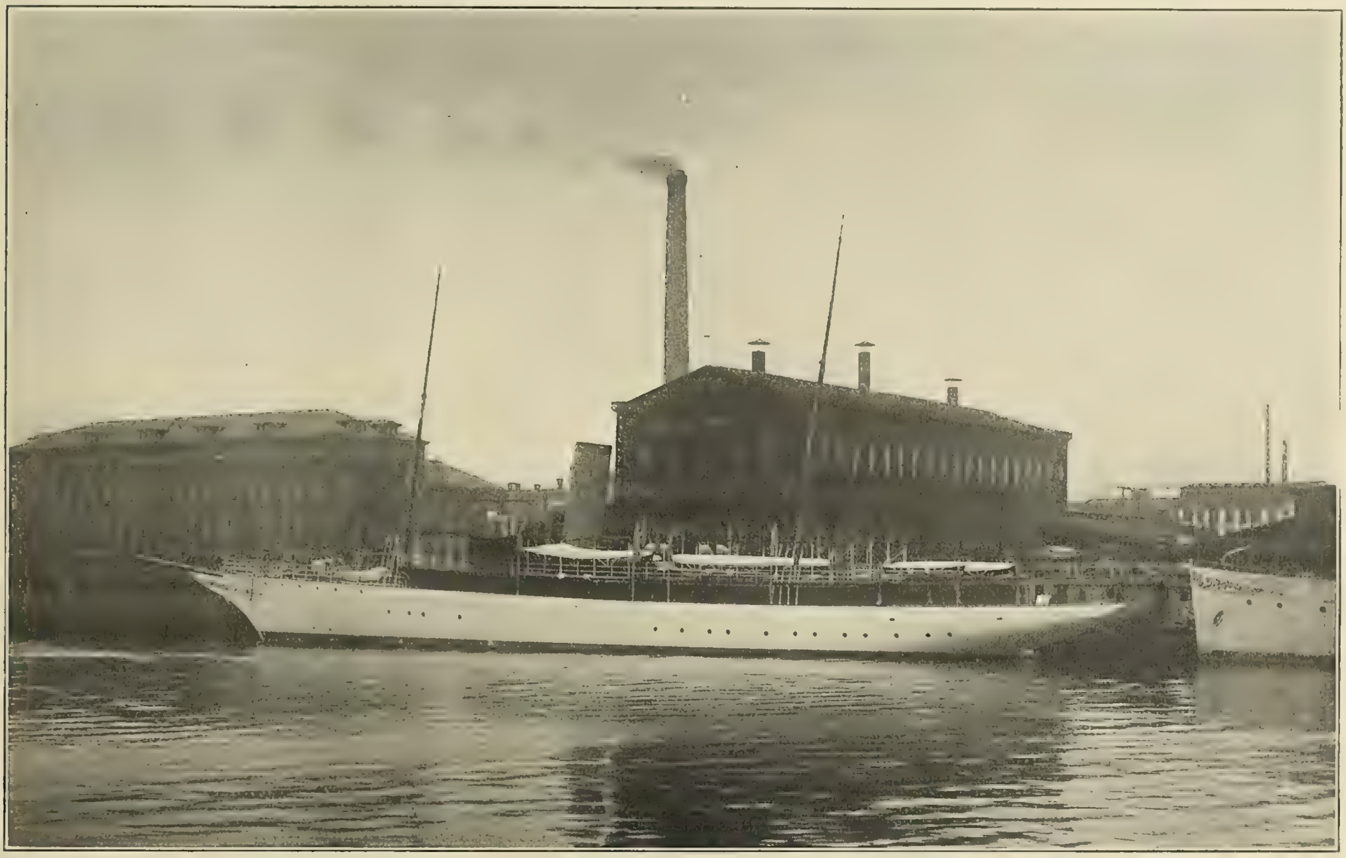
The ship is plated flush above the load waterline, and in, out and in strakes below. Fresh water tanks are built in the hull, with a total capacity of 5,000 gallons. The forward tank is located forward of the transverse bunker, and the after one directly aft of the engine space, being recessed at the center line to suit the thrust bearings. These tanks are fitted with baffle plates and manholes for access, and every provision made to insure water-tightness. A watertight door of government style is worked in the fire-room bulkhead, fitted to operate from either side.

The wood deck house is built upon a skeleton framework of steel, the front of the house being a complete steel bulkhead, well stiffened by angles and sheathed with teakwood. Four athwartship steel bulkheads, suitably stiffened by angles, are worked in the house for transverse stiffness.

Above the load waterline the hull is evenly cemented and covered with four coats of paint, the first coat being red lead mixed with linseed oil. All built-in tanks were tested with a head of water to the height of the bulwark rail for absolute water-tightness.

Aft of the crew space are the officers' quarters, consisting of six staterooms, one bath room and lobby, and entered directly from the forecastle deck by means of companion hatch above. The lobby is finished in butternut and the officers' staterooms are cork painted in white, with butternut trim and furniture.

Forward of the cross bunker and next aft of the officers' quarters come the owner's accommodations, consisting of two large staterooms, occupying together the full width of the ship, a smaller stateroom, a bath room and a lobby, reached from the main deck passage by means of a curved stairway of solid African mahogany. The lobby is also finished in selected African mahogany, handsomely paneled and matched for color and grain, rubbed to a dull, smooth finish. The owner's staterooms are finished in solid white mahogany, and contain large, specially designed canopied beds, divans and bureaus fitted with mirrors of beveled plate glass. Roomy wardrobes are built in each stateroom. The bath room is finished entirely in white, the floor and walls being tiled to height of belt rail with white glazed tiling fitted with sanitary base and of a neat pattern. This bath room contains a tub, lavatory and toilet to match finish of room, and is ventilated and lighted by a lean-to skylight on main deck at side of house and by air ports.



STEAM YACHT BUILT FOR WILLIAM A. LYDON BY PUSEY & JONES COMPANY FROM DESIGNS BY WILLIAM GARDNER

Interior Arrangement

The space forward of the collision bulkhead is fitted up as a paint locker, with access through a watertight scuttle in the forecastle deck and by means of a steel ladder. On the berth deck next aft of this bulkhead comes the forecastle, with accommodations for a crew of fifteen men and fitted with galvanized steel pipe berths arranged to swing upward when stowed. In the after end of this space is fitted a stateroom with two built-in berths for the use of the quartermasters. Access is obtained by a steel ladder from the hatch in forecastle deck, and ample ventilation secured by a cowl ventilator and four air ports on each side of ship. A hatch in the berth deck leads to a wash room and toilet for the crew in the aft-end of lower forecastle, in which are also located four additional swinging pipe berths for the crew. Directly aft of the collision bulkhead and beneath the berth deck is located the chain locker, of sufficient size to stow 150 fathoms of chain cable, the chain pipes passing through the forecastle, and raked forward to minimize noise in handling chain.

The guest's living quarters are on the berth deck aft of the machinery space and separated from it by a heavily insulated bulkhead to deaden the sound. They consist of six single staterooms, three bath rooms and a large double stateroom and linen locker. They open into a fore and aft passageway, which is accessible by a stairway and balustrade from the after end of the library on the main deck. The berth deck passage is finished in paneled African mahogany, the panels extending from deck to deck, vertically, forming a pleasing system of single paneling, all the material being selected stock, rubbed to a dull, smooth finish. Staterooms 1 and 2 together occupy the full width of the ship, and are finished in solid white mahogany, with specially designed built-in beds of the canopy type, bureaus with beveled glass mirrors and cushioned settees, fitted with lee-boards. Ample clothes space is provided in the shape of built-in wardrobes, and cheval glasses are fitted in the wardrobe doors.

State-ooms 3, 4, 5 and 6 are finished in white panel work, with African mahogany trim and furniture. The ceilings are neatly paneled. Cushioned settees, bureaus and wardrobes are all of special design.

Farthest aft is located the double stateroom extending the entire width of vessel, finished in African mahogany and ventilated by a large skylight above on main deck. A large double bureau and dressing table is built against the after bulkhead in this room, and large clothes lockers fitted on either side of the ship.

The three bath rooms are finished similarly in white, with vitreous tile of selected pattern on the floor and glazed tile on walls, with mahogany cap rail, the tiling being of pleasing color and pattern. Each room is fitted with the latest improved type tubs, lavatories, etc., and are connected by communicating doors with all the staterooms.

Refrigerating Plant

In the after end of the lower forehold a large refrigerating room is built into the ship, completely lined with sheet lead and heavily insulated with 3-inch thickness of block cork, every provision being made to secure a first-class icebox. Compartments for ice, meats, vegetables and other perishable stores are provided. Arrangement has been made for refrigerating machinery which will be installed in the near future.

Main Deck Arrangement

In the forward end of the main deck house is located the dining saloon, extending the entire width of the house and affording a complete view forward and on each side. It is finished in selected teak, handsomely carved and paneled, and of very attractive design. It contains a large circular extension table of polished teak, capable of seating sixteen persons. In the forward end of room is built a teak serving table with lockers, etc., under and containing a coil of steam pipes for heating purposes, all concealed in the wood work. In the after end is built a sideboard or buffet of teak, beautifully carved and fitted with drawers, lockers, etc., the upper portion consisting of closets, with leaded glass doors of special design. The solid substantial effect of the furniture of this room adds greatly to its appearance. The ceiling paneling is finished in dull gilt. Leading aft from the dining saloon on the port side is a door to the pantry, which is connected with the galley.

Aft of galley is the fiddley, on the starboard side, aft of which is located a large drying room fitted with lines and hooks, and aft of this room is a deck toilet. On the port side an oil locker and lamp room is located leading directly off the main deck. Next aft is the upper engine room, the sides of which are finished in dull white panel work. On the starboard side is a large observation window, affording a view of the upper engine room from the deck passage.

The after end of deck house is divided into two large rooms intended to be used as music room and library. The forward room is fitted up at the sides with bookcases with leaded glass doors to the level of the deck house windows. This is a very roomy apartment, and being furnished with a plentiful supply of light from the dome skylight overhead should prove a comfortable living room. The after room has a conveniently placed built-in sofa, and the main mast which passes through this room is handsomely ceiled over. In the after starboard corner is the stairway and balustrade to lower deck accommodations.

Both of these rooms are paneled in solid African mahogany, finished in a dull polish. The ceilings are finished in dull gilt. The main deck passageway on the starboard side of the deck house is finished in African mahogany panel work, the panels being of a single vertical type and finished dull. This type of paneling is carried throughout the ship in owner's quarters and lower deck passage aft, and gives a very pleasing effect. Ceiling in passageway is of light buff color.

From forward end of main deck passage a stairway leads to chart house on shade deck. Chart house is built of solid teak outside and finished inside in African mahogany. This room is intended to be used also as a smoking room.

Outfit and Equipment

A double-cylinder steam yacht windlass, made by the Hyde Windlass Company, is fitted on the forecastle deck for handling anchor chain. It is also equipped with gypsy heads for working falls leading from power launches and heavy boats on the shade deck, which are carried forward to the windlass through snatch blocks, chocks, etc. This arrangement admits of handling the heavier boats by means of the windlass.

The *Lydonia* is equipped with a steam steering engine of the Williamson type. It is located in the engine room and connected with the steering column on bridge by means of heavy turned steel shafting and specially designed gearing, the unusual feature of these gears being that they are fitted entirely in the shops and completely alined before being erected on the ship. Leading from the steering engine to the rudder quadrant are 1-inch diameter steel wire cables carried through brass tubing, filled with heavy grease, thus increasing the life of the cable and at the same time eliminating noise in the quarters.

On the main deck aft, directly over the rudder head, is fitted a hand steerer of the diamond screw type, with 48-inch steering wheel, the gear being encased in a polished teak wood box.

The usual system of mechanical telegraphs and speaking tubes is fitted of the Corey type, and also includes a speaking tube from pantry to the provision compartment in the forward hold.

The outfit of launches and small boats consists of a 28-foot owner's launch, a smaller 20-foot power launch, an 18-foot cutter, a 14-foot dinghy and two 21-foot life boats. The owner's launch is powered with a 30-horsepower Holmes motor, giving the boat a speed of about 18 miles an hour. The smaller launch is powered with a lighter motor of the Bridgeport make.

Machinery

The main engine is of the vertical, inverted, direct-acting, triple-expansion type, with four cylinders. The diameters of the cylinders are 16 inches, 26 inches and 30 inches, all with a common stroke of 24 inches. All parts are designed to sustain a working pressure of 200 pounds gage. The main valves are of the piston type, operated by the Stephenson link motion with double bar links. Each main piston has a piston rod with a cross-head working in a box guide. Back and front columns are turned steel forgings, well braced. The crankshaft, piston rods, connecting rods and working parts generally are of open-hearth wrought steel. The reversing gear consists of a steam cylinder 7 inches diameter and 12-inch stroke, acting through a piston and cross-head directly on an arm on the reverse shaft and controlled by a lever at the starting platform. The throttle valve is balanced and of the double poppet type, operated from the starting platform and next to the reversing lever. The crank, thrust and line shafts are 8 inches diameter, finished; the tail shaft 8¼ inches diameter, solid forged steel throughout, the cranks having a throw of 12 inches and the thrust shaft having collars forged on in the usual manner. The propeller shaft is incased in a brass pipe, shrunk on, and made watertight in way of the stern tube, and turned cast bronze sleeves fitted in way of the bearings.

A complete water service and lubrication system is fitted, consisting of multiple-feed oilers with sight-feed cups. The multiple-oiler is filled by gravity from a tank in the upper engine room. Grease cups are used extensively. The water service is of polished brass pipes to all bearings, crank, thrust bearings, etc. The thrust bearing is of the horseshoe type, with cast iron base, designed to hold oil and water. Shoes are of cast steel, lined with white metal and fitted with oil cups. Spring bearings to support line shafting are of cast iron, lined with Babbit metal, and fitted to be oiled from engine room if necessary.

The turning gear consists of a cast iron worm wheel fitted in the center of the after engine coupling and operated by a detachable composition worm gear with ratchet and lever. The condenser is of the cylindrical type with cast iron body and water ends. The tubes are of brass, ¾ inch outside diameter, tinned inside and out. The propeller is four-bladed, cast solid, of manganese bronze.

Electric Outfit

There are fitted two General Electric generating sets of 10 and 4-kilowatt capacity. A switchboard of marbleized slate is located in the upper engine room on the after bulkhead, and fitted with all necessary switches and instruments, etc.

Chloride accumulators of the marine type, in vulcanized rubber jars with caps, are fitted in lead-lined boxes and installed in a battery room in the after-hold, with ventilation by means of mushroom ventilators on main deck. On the bridge is installed a 14-inch searchlight projector. The searchlight is of 20 amperes capacity and is fitted with a lens mirror. In addition to the usual oil lamps the navigating, binnacle, telegraph and gangway lamps are fitted for electric lighting, all with watertight receptacles. All switches for lights and bell calls throughout the ship are of the flush push button type.

Boilers

The main boiler is of the cylindrical, marine firetube type, constructed for a working pressure of 185 pounds, and tested to 225 pounds hydraulic pressure. It is 14 feet 3 inches diameter, the shell plates are 1 5/16 inches thick, of a tensile strength of 60,000 pounds. The boiler has three corrugated suspension furnaces of the Morison type, with separate combustion chambers. The tubes are 3 inches outside diameter, lap welded, charcoal iron.

The donkey boiler is of the vertical type, 4 feet 9 inches inside diameter. It has shell plates of ⅜ inch thick steel plate, and is constructed for a working pressure of 150 pounds. It has stack connection with the main funnel, and is located in the lower fire-room convenient to the coal bunkers. In the lower fire-room is also located an ash ejector of the hydropneumatic type, fitted with all necessary pipes, valves, etc., for discharging overboard. Arrangement is also made for hoisting ashes by hand to main deck.

Pumps and Auxiliaries

The air pump is a Simplex vertical single-acting beam air pump, made by the Blake & Knowles Steam Pump Company. The circulating pump is of the side suction, centrifugal type, made by the Morris Machine Works. It is direct connected to a vertical engine, the pump having a vertical discharge and fitted with a composition runner. It is capable of supplying at 250 revolutions per minute 1,200 gallons per minute.

The main and auxiliary feed pumps consist of two Admiralty type vertical duplex pumps, composition fitted, for a working pressure of 200 pounds. They are manufactured by Blake Steam Pump Company.

The bilge, ballast and fire pump is of the horizontal duplex piston type, composition fitted, for a working pressure of 175 pounds. In addition to the ordinary connection this pump is piped to supply circulating water to the condenser in case the circulating pump is out of order.

The donkey boiler pump is a Blake horizontal, duplex piston pump, composition fitted.

The sanitary pumps are of the horizontal, duplex piston type, fitted with governors to regulate the water pressure at the service tanks.

A multi-coil feed-water heater is installed, capable of heating the feed-water to 225 degrees F., using exhaust steam from auxiliaries.

The forced draft system is of the closed ash-pit type, and consists of a Sirocco fan with single inlet, direct connected to a vertical inclosed steam engine, furnished by the American Blower Company.

The hot well and filter box are of galvanized iron and fitted with an automatic regulating valve direct connected to feed pumps.

The main steam and main engine piping are of copper with composition flanges. The piping generally is of brass or copper. All salt-water piping is of copper, as are the feed lines and blow-off piping. The fresh water piping is of galvanized iron for sizes of 2 inches or under, above this size of copper. All valves of 2½-inch size and under are of composition, and above this size are composition fitted. Lunkenheimer high-pressure valves are used throughout.

Westinghouse High-Speed Reduction Gear.—The largest direct-current turbo-generator set yet constructed has been built by the Westinghouse Machine Company and the Westinghouse Electric & Manufacturing Company, East Pittsburg, Pa., for one of the stations of the Cleveland Electric Illuminating Company, Cleveland, Ohio. The speed of the turbine is 1,800 revolutions per minute and the rated capacity of the generator 3,750 kilowatts. By interposing a Westinghouse reduction gear with a ratio of 1 to 10 between the turbine and the generator, the latter is driven at 180 revolutions per minute. The reduction gear embodies the hydraulically-supported "floating" pinion frame of the type recently installed in the naval collier *Neptune*. The generator efficiency being 94 percent the gear transmits 5,350 brake-horsepower, although on several occasions the load has been in excess of 6,000 horsepower. It is expected that this plant will demonstrate that two gears of this size, each with two pinions driven by separate turbines, will be sufficient for driving the largest battleships of the *Dreadnought* class. The above gear does not exceed in capacity the experimental set tested at the Westinghouse Machine Company's works in 1909, but the reduction ratio is twice as great, and the turbine speed is 20 percent higher.

Submarine Contracts.—Contracts for eight submarines were awarded at the Navy Department Dec. 31. The work is divided between the Lake Submarine Boat Company, Bridgeport, Conn., and the Electric Boat Company, Groton, Conn., the former to build three and the latter five boats. At the present time eight submarines are under construction on the Pacific Coast and seven on the Aatlantic coast.

Dutch Shipping Exhibition.—The first Dutch shipping exhibition, which is to be held at Amsterdam from June to September, 1913, and which has the material support of the Government of the Netherlands, was organized to mark the anniversary of the Treaty of Ghent, which made Holland an independent kingdom, and also to celebrate the opening of the Peace Palace at The Hague.

Correction.—On page 13 of our January issue in the article on "Experiments on the *Fulton* and *Froude*," by Prof. C. H. Peabody, the formula for indicated horsepower, as printed, contains a redundant factor, *L*.

Marine Turbine Operation and Economy

BY LIEUTENANT-COMMANDER H. C. DINGER, U. S. N.

In practice it has been noticed that there are often very wide variations in the steaming economy of similarly engined turbine vessels, especially at low and medium speeds. The popular belief, largely fostered by the literary campaign of the turbine promoters, is that the only manipulation of the turbine plant lies in the throttle valve. This is decidedly in error, and intelligent operation and management may expect to reap the same substantial gain that it can in other installations. As a matter of fact, the most particular care and precise attention to details are required to obtain the most satisfactory results.

In connection with the operation of marine turbines there are various practical points of operation not largely touched upon in turbine literature. Many of these things have developed from the experience gained in operating the new turbine battleships and destroyers, and have become topics of discussion among those interested. Most of this experience has been with the Parsons turbine, since the majority of the new battleships and destroyers have turbines of that type.

Perhaps the most radical development over previous practice abroad is the so-called quick method of warming up. The original practice in warming up turbines was to turn steam on very slowly or to admit steam of low-pressure, and then allow the turbines to heat up gradually without attempting to move the rotor, or only moving the rotor occasionally by means of jacking gear. Then after five or six hours, when it was believed that all parts were properly heated up, to turn the rotors over with steam. This practice has during the last few years been superseded by what has come to be called the "Quick method" of warming up. This method was apparently first developed in connection with destroyers, where the necessity for getting underway on short notice is particularly present. The elements of this method are embodied in the following set of instructions which have been successfully used in practice, and a similar method is now largely used on vessels using Parsons marine turbines. Account is to be taken of the fact that this set of instructions applies particularly to a Parsons three-shaft arrangement fitted with high-pressure and intermediate-pressure cruising turbines.

Warming Up Turbine Engines

Never try to warm up any of the turbines with auxiliary exhaust connection. Auxiliary exhaust may be turned into turbines only after they are warmed.

Drain water from lubricating oil settling tanks.

Open all drains on main steam lines and also turbine drains.

Open auxiliary exhaust to second expansion of main high-pressure turbine in order to drain off water which has collected; close when water has been drained off.

Start oil circulating pump, bypassing cooler, and see that all turbine bearings and main circulating pump bearings are getting oil.

Start main circulating pump slowly.

Start one air pump slowly, obtaining about 5 to 10 inches of vacuum on main condensers. Do not have more vacuum, for otherwise the turbine may speed up when steam was admitted to them in warming up, and it is necessary to stop quickly if anything rubs.

See jacking gear out.

Open bulkhead stop valves and see that self-closing valves on main high-pressure and high-pressure cruising turbines are open. Open one boiler stop about one-half a turn and let steam blow through system for about three or four minutes, or until throttle valves are thoroughly heated. If turbines start to turn it will be necessary to close valves, but this is not likely to happen.

After throttle valves are thoroughly heated, close them and let steam pressure rise to about 150 pounds.

If all turbines are connected up, give main high-pressure turbine jets of steam, just sufficient to turn it over; do this several times, so that it will be warmed up thoroughly and evenly. Then do the same, first with port low-pressure, second with starboard low-pressure, third with intermediate-pressure cruising, and last with high-pressure cruising turbine, between times giving the backing turbines a few jets of steam.

If turbines do not readily turn, steam may be put on cruising and low-pressure turbines at same time to start them. Keep blowing steam through the different turbines for 20 minutes or a half an hour; by this time the entire system should be thoroughly warmed up. The idea of opening one boiler stop about one-half turn is to have only just enough steam to turn the turbines over slowly and prevent them running away, which might happen if full pressure was admitted. In order to prevent any of the moving parts of the turbines from touching on the fixed parts, *thorough* and *even* warming up is absolutely necessary, and this can only be done when the rotors are moving so that the steam comes in contact with all parts.

Steam may be turned on the glands any time during the warming up of the turbines; about 1 pound is sufficient.

After 20 minutes or one half hour, when turbines are thoroughly warmed, open boiler stops and get permission to try engines from bridge. Take micrometer readings while engines are being turned over.

When everything is ready, report department. Keep putting jets of steam through all turbines while waiting for orders, so as to keep them warm.

A few minutes before getting under way, the bridge should notify the engine room, so that the main air and circulating pumps may be speeded up and the augmentor cut in.

The above quick method is in very general use on recent destroyers. It originated with the Bath Iron Works, and has been found to be very satisfactory in practice, and a similar method will no doubt be adopted by nearly every Parsons turbine installation when it is discovered that the long and tedious process of slow warming up is not only unnecessary, but also more dangerous.

The danger of touching blades in starting up is due to lack of uniformity of temperature, and is not a question of low temperature. The parts might all be ice cold, but as long as all parts were uniformly cold, no touching can result. In order to heat up uniformly heat must be distributed to all parts. Admitting steam, though of very low-pressure, to a turbine without revolving the rotor is bound to heat some parts a great deal more than others. Of course, if the process is long enough, eight or ten hours, a rather uniform condition of temperature will be obtained. However, by revolving the rotor by steam, the steam is bound to be distributed all along the blading, both longitudinally and radially, and all parts are heated in a very uniform manner. Revolving the rotor by means of jacking gear is of little or no use, unless some steam is entering the turbine while this revolving is taking place. The rotation of the rotor should be used to distribute the steam, and hence the heat, over all the steam contact surfaces. This can be done very efficiently by injecting gusts of steam into the turbines and thus starting it revolving. This really warms the turbines uniformly, and as long as heat is uniformly distributed circumferentially it does not make much difference as to the distribution of heat longitudinally, except that there ought to be a gradual fall in temperature from one end of the turbine to the other.

There is thus no need for long periods of preliminary heating. The main thing is to get the turbine revolving by the action of the steam, or to have the rotors revolving while steam is being admitted.

Neither is it believed that the size of the turbine should make any particular difference; though of course it will take a larger turbine longer to get up to its final working heat. If desired the process of warming up by puffs of steam can be continued longer than with a smaller turbine.

On large vessels this method may be modified by first revolving the rotors by means of the jacking gear for half an hour or more, while the gland steam is on and the throttle bypasses opened slightly. After this is done, then throw out the jacking gear and move the turbines successively by giving them puffs of steam with the throttle, as in the quick method of warming up. With large turbines there is not much danger of the turbine running away. A fairly high vacuum can be carried while trying out turbines, and a fairly good throttle opening is required to start them turning.

This method can be used where power jacking gear is provided, and is thoroughly safe, since the rotor is being revolved while steam is being passed through the turbine. The danger in warming up comes from admitting steam without revolving the rotor. This causes a local and uniform heating and a consequent distortion of some part which may touch when the rotor is next revolved.

The slow method of warming up is apparently the most dangerous, since by admitting steam at one point and only moving the rotor occasionally uniform heating is hardly posssible, and there is no way of telling how long it will take the turbine to acquire its uniform expansion. It may take two, three, six or eight hours, and depends upon the variable amount of steam that may be admitted.

In the slow process of warming up we begin by distorting the rotor and casing by heating some parts more than others, and then wait till the other parts get up to a uniform temperature by conduction. In the quick method we do not distort the turbine, but simply gradually heat up all parts in as nearly a uniform manner as possible.

From results of practice there is not yet known any case of stripping blades due to warming up by quick method, while cases of stripping due to improper warming by the slow method are many. The slow method is no doubt safe if plenty of time is taken—five to six hours; but life is too short to employ such a waste of time.

Operation of Turbines

Handling of Throttle.—A turbine requires more time to speed up to the required revolutions, and also does not stop as promptly as a reciprocating engine. Time should be given to work up to power, and sudden opening or closing of the throttle is not deemed advisable. A sudden opening of the throttle is liable to cause the joints around the glands to leak, and may also cause priming, which, if very bad, may cause some of the blades to be loosened. After steady speed has been secured, constant revolutions can be maintained by keeping a constant receiver pressure, but while the speed is being changed the receiver pressure does not give much of a guide. Throttles may sometimes stick, especially the backing throttle, when not used for a long time. Opening the bypass will usually warm it and loosen it up.

Clearances.—The dummy clearances will change from various causes. The chief cause for change is the warming up, or cooling of the turbine, and whether the steam thrust or propeller thrust is predominating. On starting out clearances are usually larger than after the turbines have reached their full working heat. At low power the propeller thrust predominates and the clearances are low, due to the fact that the rotors are in. The depth of the water will also affect the position of the rotor, since it will alter the thrust. At high speeds the steam thrust will predominate and the rotors will move out, causing increased clearances. The combination in use and the proportionate power on the different turbines will affect the position on the rotors. This being the case, the rotor can be made to change its position, more or less, by a change of combination and by admitting steam in one place or another. Thus a low-pressure on one side may to some extent be forced out by putting more auxiliary exhaust into it. This can be done by shutting it off on the other side, or by cutting some out of the feed heater. A main high-pressure turbine can be moved out when in cruising combination, by opening its throttle bypass, thus giving a little higher steam pressure, and consequently a greater steam thrust, or in case a main high-pressure rotor should come in so as to be dangerous when using a cruising combination; cutting out cruising turbines and running with main plant would tend to move the rotor out. It is well to notice that the position of the rotor can thus be varied, because it may be made use of should some of the clearances become dangerously low. A safe position of rotor may possibly be secured by some manipulation of throttles and connections, as cited above.

Clearances, however, are often known to change for no manifest reason, but it is not always certain that the micromometer is read rightly. Sometimes the end of the micromometer rod becomes burred or is grooved by the rotor so as to cause inaccurate readings to be taken.

Manipulation of Gland Steam.—The high-pressure and the cruising turbine glands have leak-off connections to the condensers. Through these connections considerable steam may be lost, when it is not at all necessary. If the leakage out is very considerable, it may be necessary to open the leak-off to the condenser, but as much as possible of this leak-out should be utilized to pack the low-pressure glands which are under vacuum. If the leak-out is considerable the supply of steam to glands for steam pipe may be closed off. The amount of leakage varies with the pressure in the turbine, and also to a considerable extent with the position of the rotor. High dummy clearances apparently call for a greater supply of gland steam. In changing from one speed to another, the gland steam requires adjustment, and usually if once adjusted for a steady speed little regulation will be required, until speed is again changed.

Backing.—This should not be done too suddenly—that is, by very quick opening of the throttle. A quick opening is likely to cause priming. In backing, regard should be had for the boiler power at the time available. If only a portion of the boilers are connected, a considerable opening of the throttle will cause the steam to be taken faster than it is generated, and the pressure will be run down in a very short time. Hence it is better to start backing gently and then open up as much as possible, and still maintain a sufficient steam pressure in order that the risk of having the auxiliaries bucking may be obviated.

Securing Turbine Engines.—The forced lubrication pumps should be run for some time after the engines are stopped in order that the cool and clean oil may be at all the bearings. The air and circulating pumps should be run for several hours with the turbine drains open, in order that all possible vapor contained in the turbines may be drawn off. Turbines should be jacked to drain joints, to facilitate water in bottom of casing being drained off. The thorough drying out of the turbines in this way prevents corrosion.

While in port the air and circulating pumps should be operated for a short time every few days in order to draw off any moisture that may have collected.

(To be concluded.)

Steam Lumber Schooner John A. Hooper

The Harlan & Hollingsworth Corporation, of Wilmington, Del., has just completed and delivered a steel lumber steamer for Sudden & Christenson, San Francisco, Cal., intended for service in the transportation of lumber along the Pacific Coast of the United States. The length over all is 299 feet, length as per Lloyd's rule 284 feet, molded beam and depth are 44 feet and 21 feet 6 inches respectively, with a double bottom 3 feet 6 inches deep at the center line. The poop and forecastle have a height of 8 feet 6 inches, while the bridge has a height of 12 feet above the main deck. The propelling machinery is at the extreme stern. The vessel is schooner rigged with three masts, the fore and mizzen masts each carrying two 75-foot cargo booms, and the mainmast four 75-foot booms. Special attention has been given in designing the rigging to handle the cargo of lumber efficiently and rapidly. There is one complete steel deck and a double bottom extending all fore and aft, which, with the fore peak, is to carry oil fuel. Deep trimming tanks are fitted in the vessel so that she will draw about 11 feet forward and 15 feet aft, with all the bottom and peak tanks full. The officers, firemen and oilers are located in the poop, while the sailors are berthed in the forecastle.

The deck machinery consists of a steam capstan of Hyde make located on the poop deck for warping the vessel. The engine is 6 inches by 8 inches with a gypsy head 18 inches in diameter. A steam brake windlass of Hyde make is fitted on the forecastle deck with 9 inches by 9 inches vertical engines with wildcats suitable for handling 1¾-inch chain cable. A vertical steam steering engine 7 inches by 7 inches of the patent combined steam and hand quadrant steerer friction type is located in the poop and directly connected to the rudder quadrant through a friction device. There are also four horizontal hoisting engines of the Murray pattern, 8 inches by 12 inches double cylinder, double drum, and a towing machine located on the poop deck of the Shaw & Spiegel type, having double horizontal cylinders 14 inches by 14 inches, suitable to handle a 1¾-inch steel wire towline.

The vessel is built on the deep frame principle, so as to allow the lumber to lay up close and to avoid broken stowage. The double bottom is made oil-tight in order that fuel and freight oil may be carried. The tank top forward is raised in order to obtain continuity of strength; No. 2 tank above the tank top is arranged for carrying water ballast. The cargo hatches are of the twin type with steel covers, and the deck is provided with continuous girders fore and aft, being of single plate on each side of the hatch; this arrangement gives great strength and first-class compensation. These hatches are arranged to suit four double drum cargo winches, all particularly designed for handling lumber.

Other accessories include a wireless telegraph system, a warning signal system, a tell-tale of the General Electric make fitted in the pilot house, to indicate whether the running lights are lighted or not, and a 14-inch searchlight installed on top of the pilot house having a pilot house control. The vessel is lighted throughout by electricity. The oil-burning system is of the latest design of the Union Iron Works, San Francisco, which is a pressure system, arranged for atomizing without steam or compressed air. The vessel is designed to carry over 2,000,000 board feet of lumber on a load draft of about 17 feet 6 inches, depending on the amount of oil in the tanks.

There is no cementing in the double bottom except where water is to be carried. Two steel U-shaped fenders are filled in with pitch. Three pairs of hatches 26 feet by 14 feet and one pair 40 feet by 14 feet wide, fitted with watertight steel covers, give access to the holds. A complete pumping arrangement is provided for rapidly filling and discharging oil from the double bottom, and ballast water from the holds, while ventilation pipes for the oil compartments are fitted equal in area to the filling pipes. In the wing of the boiler room are the evaporator and ice plant equipment.

The propelling machinery consists of an inverted triple expansion, surface condensing, three-crank engine, having cylinders 21 inches, 34 inches and 56 inches diameter by 42 inches stroke, to run at about 92 revolutions per minute on a working steam pressure of 180 pounds per square inch. The air pump, two bilge pumps, and two feed pumps are attached to the back of the condenser, and are operated by a beam from the main engine, both bilge pumps having connections to the double bottom and the sanitary pipes. A 12-ton capacity evaporator is fitted up complete in the engine room with an outlet to the condenser for feed make-up. A feed water heater of the multicoil type of ample capacity is placed between the feed pumps and boilers. Steam is supplied at 180 pounds pressure by two single-ended Scotch boilers 14 feet 3 inches diameter by 11 feet 9 inches long, each having three furnaces. The propeller is a four-blade solid cast steel wheel.

Intercolonial Railway Harbor Terminals at Halifax, N. S.

BY E. A. SAUNDERS*

For years the Halifax Board of Trade has discussed the matter of a comprehensive plan of the terminals, and it is with some satisfaction that the matter has been definitely decided upon. At the present time there are nine piers in connection with the Intercolonial Railway—five of them situated at what is known as Deep Water and the balance at Richmond, about 1 mile to the north. Both sites command good positions on the harbor front, and the Richmond yards and piers are splendidly adapted for import and export trade—from this point all lumber shipments are made.

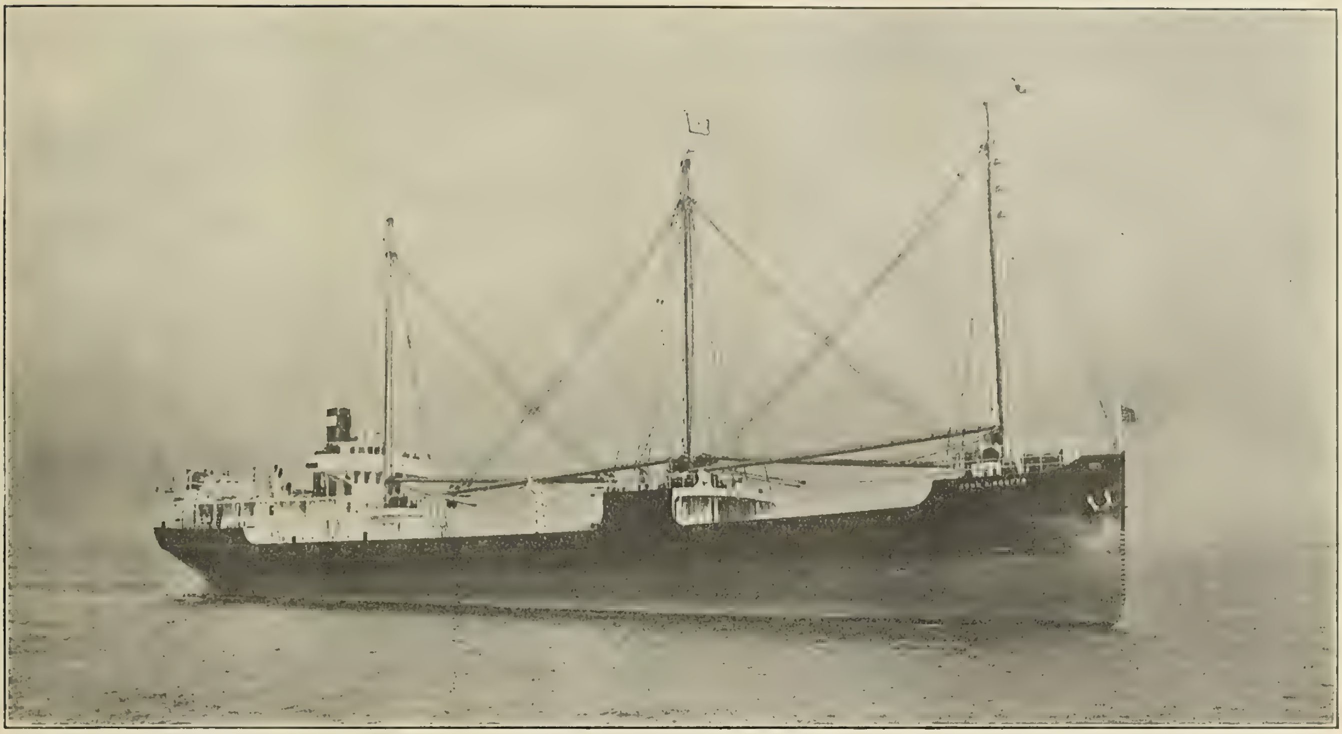
It is in connection with the piers at Deep Water that the comprehensive planning has been done. At the present time No. 3 pier is the largest, being 620 feet long and 165 feet wide. The others are 550, 490 and 450 feet long, respectively. Under the new plan these piers will be removed and four new piers constructed of reinforced concrete, three of them 800 feet long and 235 feet wide, and the other 650 feet long and 195 feet wide. The width of water between these piers will be 310 feet, 275 feet and 250 feet long, respectively.

The first pier, now under construction, and known as No. 2, is being built on what is known as the Cunard property, which was purchased by the Government some five years ago for $165,000 (£34,000). The contract to build this pier was secured by the Nova Scotia Construction Company, which has opened an office in this city, and the figure for the wharf portion and shed, without appointments, was $914,600 (£187,500).

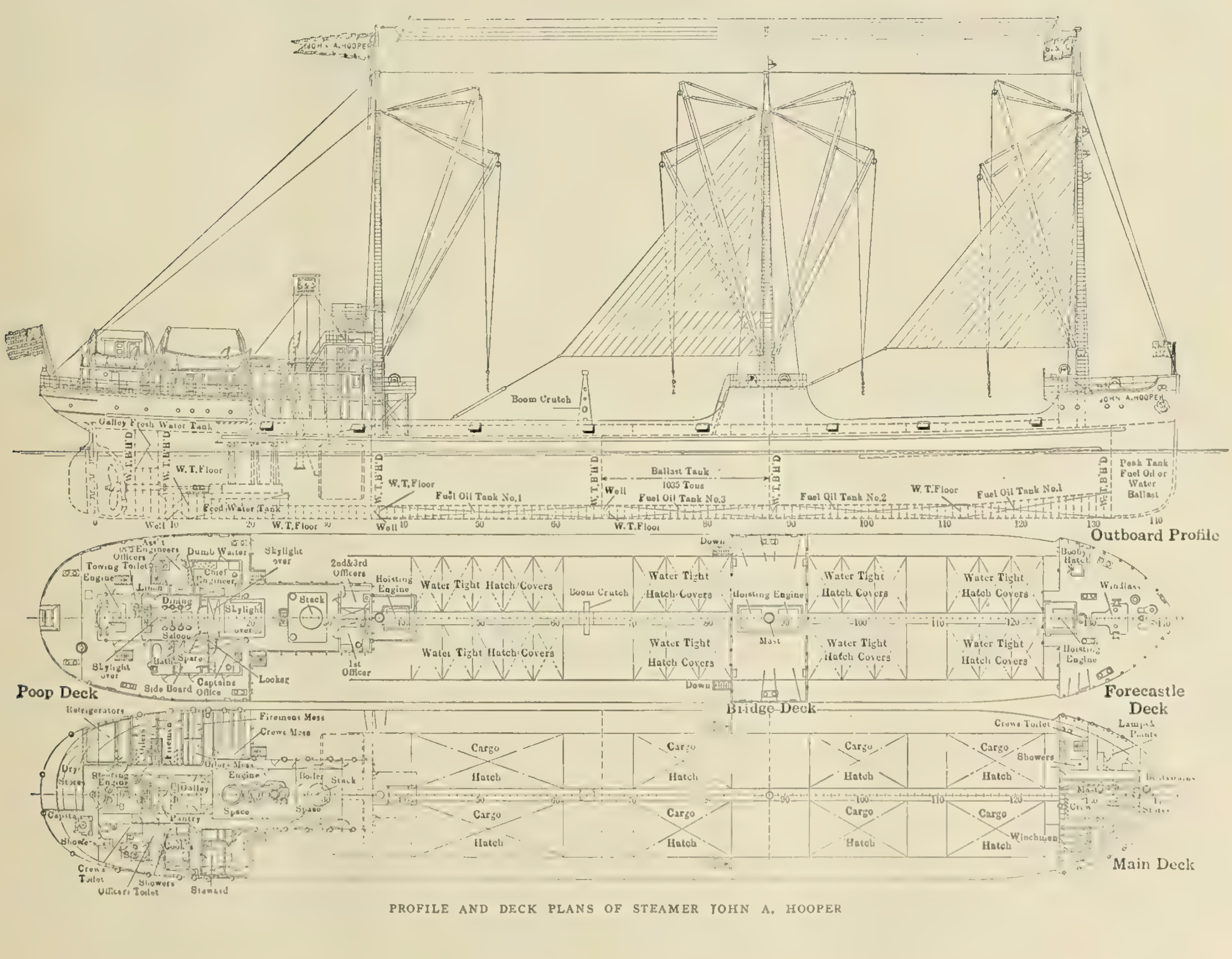
The contract calls for the clearing of the present site of the existing buildings, to deepen, if necessary, the basins on either side of the pier so as to give a depth of water of 34 feet, and the shed walls are to be of concrete with iron window and door frames—the doors being 16 feet high. There will be a depth of water of 65 feet at the head or water end of the pier.

This shed will contain two floors, the lower for freight pur-

* Secretary Board of Trade, Halifax, N. S.



STEAM LUMBER SCHOONER JOHN A. HOOPER

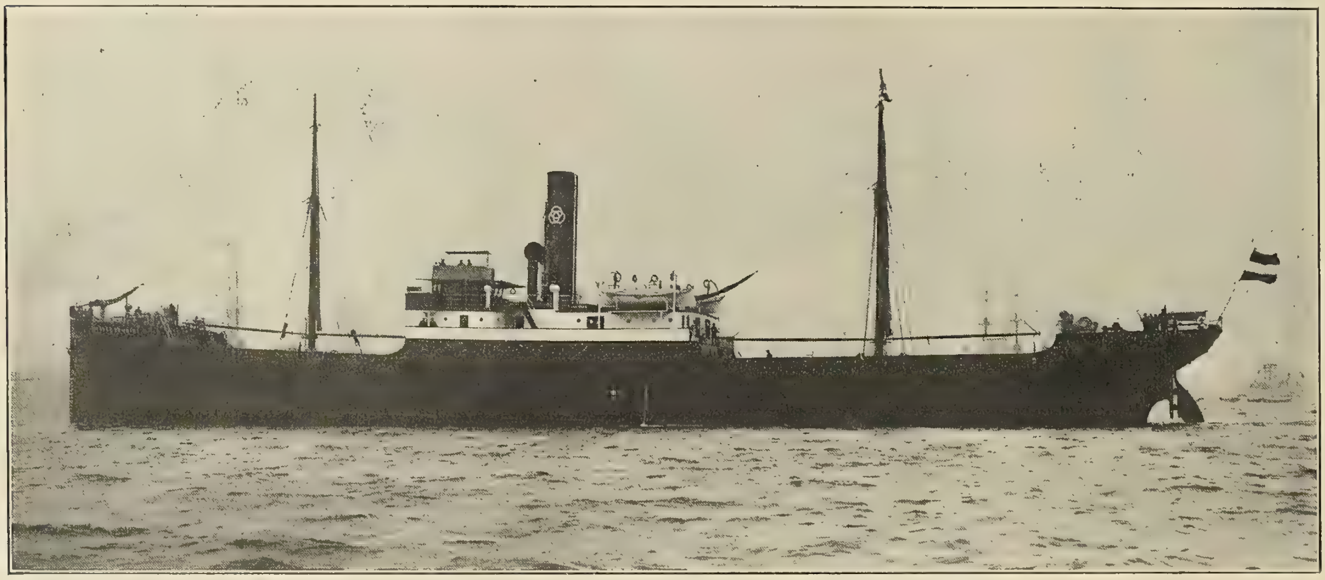


PROFILE AND DECK PLANS OF STEAMER JOHN A. HOOPER poses, and will have two railway tracks in the center inside the shed and a track on either side. The freight platform will be 90 feet wide and the entire length of the shed—720 feet. On the upper floor of this shed will be offices in connection with the Immigration Department, also for the inspection of baggage, etc., by the customs officials; there will also be a restaurant, sleeping apartments for the officials, etc. The building will be fireproof and the appointments of the very best character. This pier is one of the largest of similar construction on the Atlantic seaboard.

Pier No. 4 is of similar construction, and will also be used for passenger and freight purposes; Pier No. 3 will be used entirely for freight purposes, and No. 5 was planned for the use of coastwise steamers, etc.

is built of concrete trestles, braced, and facings and deck. The bulkhead is built in cribs or blocks reaching up to about 2 feet above low water; above that level the crib work is built continuous and finished with a coping of two 12-inch square creosoted timbers laid side by side. The cribs are filled with stone, too, at least 15 feet high above the bottom, and above that to rail level with earth or other good filling. The pier itself is built of reinforced concrete piles, calculated to stand a load of from 85 to 90 tons on each pile, driven to rock, stayed as they are driven, and the braced tiles are molded on such a curve as to make a uniform stress throughout the cross-section of the pile under a compression of 80 tons on the pile sloping.

The comprehensive plan, when completed, will total upwards of $5,000,000 (£1,025,000) of an outlay.



GERMAN ORE STEAMER DR. ADOLF SCHMIDT, BUILT FOR MESSRS. FRIEDRICH KRUPP, A.-G.

The plan also calls for the removal of the present local freight shed. This shed is of brick, with granite trimmings, and is 800 feet long by 110 wide, and for some years has been found altogether inadequate for what it is used. The purchase of the property on the opposite side of the street has been recommended and the erection of a local shed to be placed thereon. This will not only place the shed in a better position for local purposes but will give much needed yard room.

The building of the new pier does not in any way interfere with the present facilities, but to relieve the congestion of freight a shed is being erected on Pier 9 at Richmond, which is 650 feet long by 89 feet wide. The contract for the building of this shed was awarded Falconer & McDonald, of this city, and the figure was in the neighborhood of $30,000 (£6,150).

Although additional property was appropriated by the Government some three years ago at the terminal piers, which gave additional room for 800 cars, and the removal of the round-house and work shops from Richmond a year later gave additional room for 1,200 cars there, both these yards are at the present time found inadequate, and there is already a congestion, showing plainly the need of extending the facilities.

The import and export freight handled at the piers last winter was 100 percent more than the winter previous, and up to the present time it has been 25 percent in advance of last year. Among the shipping people there is a feeling that even when the present plan is completed that it will be only sufficient for present needs.

To give some idea of the construction of the new piers, a bulkhead is called for at the shore end, and the pier proper

Messrs. Krupp's New Ore Steamer

The ore steamer *Dr. Adolf Schmidt,* built at the Germania Shipyards to the order of Messrs. Friedrich Krupp A.-G., and which is named after a former director of that company, is a vessel of 3,650 tons capacity, destined for the journey to Messrs. Krupp's Spanish ore mines. Its dimensions are 286 feet 6 inches by 43 feet by 18 feet 8 inches. The engine has an output of 1,000 indicated horsepower, the speed of the vessel being 9.5 knots and the tonnage 2,246.8 British register tons.

The engine is a triple-expansion engine of 1,000 indicated horsepower, located amidships, its cylinder diameters being: High-pressure, 20 inches; intermediate, 24 inches; low-pressure, 5 inches, and the stroke 40 inches. Two cylindrical boilers, 10 feet 9½ inches in length and 13 feet 8½ inches in external diameter, as well as a small auxiliary boiler, 9 feet in length and 9 feet in external diameter, supply the steam required for this engine.

When traveling without load, the vessel can carry 946 tons water ballast in special tanks, warranting the seaworthiness required in this case. The two spacious cargo holds, each 92 feet in length, which can be subdivided by wooden bulkheads, are each controlled through two big hatchways, 23 and 19 feet in length, respectively, allowing the vessel to be filled with ore or unloaded in a very short time (four hours). Unloading is effected by means of four derricks fitted to two substantial hoists, and which are controlled by six steam capstans or else by means of grips or other mechanical hoisting devices.

Passenger Vessel for Great South Bay

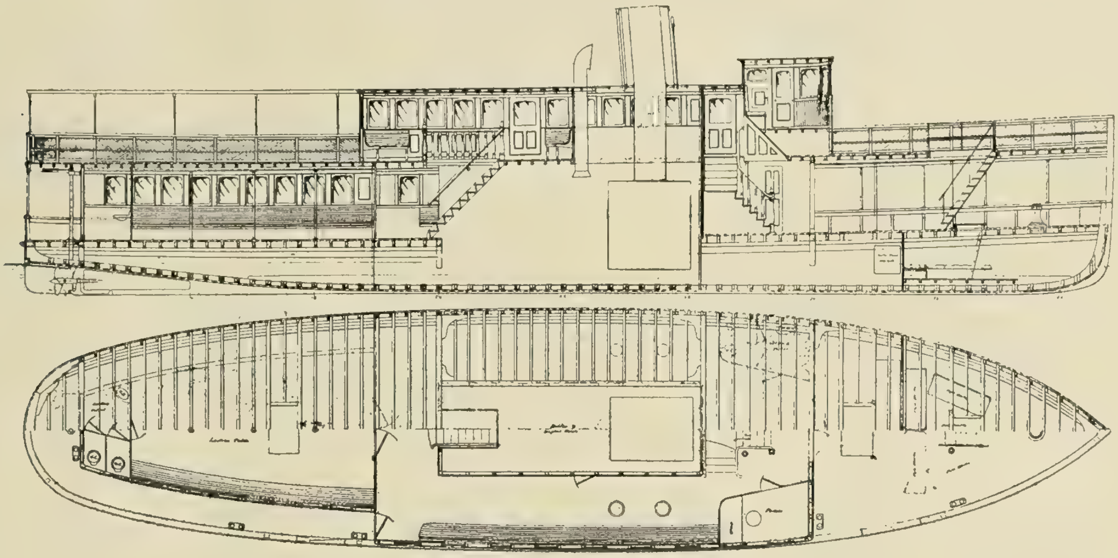
An interesting new passenger steamer is the twin-screw propeller *Patchogue,* built from designs and specifications and under the supervision of Cox & Stevens, naval architects, New York. The owners are the Patchogue & Water Island Navigation Company, of Patchogue, N. Y.

The principal dimensions of the vessel are:

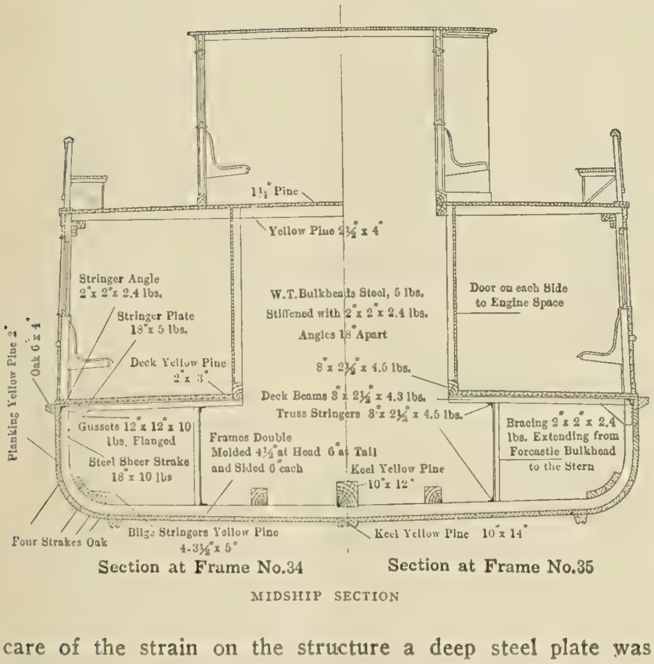
Length over all	105 feet.
Length on waterline	104 feet.
Beam	23 feet.
Draft	3 feet.

The machinery consists of two triple-expansion engines, 6 inches, 9¾ inches, 15½ inches by 9 inches stroke, placed amidships, supplied with steam by a Robert's boiler. Owing to the extremely limited draft and consequent small depth of hull, the architects were forced to give particular attention to rigidity in hull construction. A wooden hull was decided upon as being best suited for the purpose, but in order to take care of the strain on the structure a deep steel plate was worked between the planking and the frames, associated with a steel plate deck stringer under the deck, these plates being connected by a fore and aft stringer angle and heavy steel brackets at each beam, the beams also being of steel. This construction has provided for the maximum possible strain with a minimum of weight, and is associated with a longitudinal system of trussing of the hull, which does not in any way interfere with the operation of the machinery.

TWIN-SCREW, SHALLOW-DRAFT STEAMER PATCHOGUE



PROFILE AND DECK PLAN



MIDSHIP SECTION

The vessel has no stateroom accommodation for passengers, as she is for day service, but has an immense amount of deck room covered with awnings and unusually comfortable saloons and toilet rooms, all well equipped and lighted by electricity. The pilot house contains necessary accommodation for the crew. A great deal of care has been given in this design to produce a vessel that will be attractive in appearance, comfortable and economical to run.

The placing of this vessel on the South Bay is to a certain extent an experiment, and for that reason those interested wished to make the proposition as attractive as possible to their prospective clients, an end which they have ably secured. The *Patchogue* has made a good showing during her first season, having carried a large number of passengers and built up an increasing business. When certain proposed trolley connections across Long Island are completed, this vessel will take passengers to the ocean who a few hours before have been in Connecticut, having crossed the Sound on a ferry and Long Island by trolley, thus making a delightful outing.

In her trip to Patchogue from City Island this vessel naturally had to make quite an extended trip in the ocean, and although the weather was quite rough she came through comfortably and without damage. The speed is very satisfactory, being in excess of 12 miles per hour.

World's Progress in Shipbuilding in 1912

The remarkable activity in shipbuilding throughout the world recorded a year ago was in no wise abated in 1912. From statistics compiled by the *Glasgow Herald* the total tonnage of vessels launched throughout the world during 1912 was 5.66 percent greater than in 1911, thereby establishing a record never before approached. In the United Kingdom there was an increase of .24 percent; in Germany an increase of 32 percent; in the United States an increase of 19.8 percent, and in Holland an increase of 44.6 percent. The returns from France indicate a slight decrease and in Italy a marked decrease. Figures from some of the other less important maritime nations show, in general, remarkable increases in tonnage launched during the past year, and while these figures may be somewhat incomplete yet they tend to show the general favorable trend of the world-wide activity. Quoting from the *Glasgow Herald* the tonnage and indicated horsepower of vessels launched by the different countries during 1912 and 1911 are as follows:

	1912.		1911.		Increased Tonnage Built.
	Tons.	I. H. P.	Tons.	I. H. P.	Percent.
England	1,232,390	1,263,086	1,221,948	1,139,527	.86
Scotland	688,188	914,741	671,624	837,668	2.5
Ireland	164,748	93,450	186,825	150,116	—11.9
United Kingdom totals	2,085,326	2,271,277	2,080,397	2,127,311	+.24
Colonial	36,578	17,922	29,249	12,875	25.
Germany	530,312	646,025	401,881	666,785	32.
United States	321,592	324,208	268,561	257,825	19.8
Holland	258,263	112,859	178,618	101,730	44.6
France	177,883	254,595	184,411	324,205	—3.5
Japan	89,925	180,851	84,462	164,375	6.5
Austria-Hungary	83,192	89,910	68,390	48,485	21.8
Norway	53,256	58,273	38,222	41,004	39.4
Italy	35,617	201,865	86,814	148,150	—59.
Denmark	27,622	18,605	18,961	18,040	45.6
Belgium	21,329	9,215	12,489	1,798	70.7
Spain	20,372	37,750	6,760	10,800	202.
China	13,057	8,260	4,222	3,920	209.
Sweden	12,286	10,680	9,734	16,931	26.2
Russia	3,604	4,510	94,905	169,215	—91.3
Grand total	3,770,214	4,246,805	3,568,076	4,103,449	5.66

A comparison of the work done in the principal shipbuilding centers of the world during the past year is shown by the following table:

PRINCIPAL DISTRICTS

	Vessels.	Tons.	I. H. P.
The Clyde	389	640,529	873,326
Germany	408	530,312	646,025
The Tyne	97	388,376	464,855
United States	196	321,592	324,208
The Wear	82	309,934	191,806
Tees and Hartlepools	100	261,888	182,210

The largest tonnage launched by any one concern during the year was by Swan, Hunter & Wigham Richardson, a firm which has in recent years always ranked as one of the leading shipbuilders in the world, being outdistanced last year by only one concern—Harland & Wolff—which this year has fallen to sixth place.

LEADING SHIPBUILDERS

	Vessels.	Tons.
Swan, Hunter & Wigham Richardson	21	121,281
The Vulcan Company (2 yards)	11	96,639
Workman, Clark & Company	10	85,391
William Doxford & Sons	18	80,995
William Gray & Company	20	79,841
Harland & Wolff	7	77,591

The largest ship launched during the year was the Hamburg-American Company's monster liner *Imperator*, built by the Vulcan Company in their new yard at Hamburg, and which is a quadruple screw, turbine-driven ship of 52,000 tons. The second largest vessel launched was the White Star liner *Ceramic*, building at the Harland & Wolff yards at Belfast. She is a triple-screw vessel of 18,500 tons, driven by combination reciprocating and turbine engines. The sister ships, *Empress of Russia* and *Empress of Asia*, of 16,850 tons each, building by the Fairfield Company, are the next largest vessels launched. They are also turbine-driven ships with quadruple screws, and are destined for the Canadian Pacific Railway Company's Pacific service. While the bulk of shipbuilding during the year was of comparatively small tonnage, nevertheless the twin-screw steamer *Nestor* of 14,500 tons, under construction at the yards of Workman, Clark & Company, and the triple-screw steamer *Niagara*, of 13,342 tons, fitted with combination reciprocating and turbine machinery, building at Clydebank by John Brown & Company, should be classed among the leading vessels.

A better comprehension of the conditions existing in United States shipyards may be obtained by referring to the reports of the Bureau of Navigation of the Department of Commerce and Labor for the calendar year ended Dec. 31, 1912, which cover the mechant tonnage completed and registered. According to these reports, 1,727 sailing, steam and unrigged vessels of 292,477 gross tons were built and officially numbered during the year. During the corresponding year ended Dec. 31, 1911, 1,592 sailing, steam and unrigged vessels of 309,640 gross tons were built and officially numbered, indicating a slight decrease in merchant tonnage. Including the warship tonnage, however, as is done in the reports compiled by the *Glasgow Herald*, which take into account the vessels launched and not those completed, the total amount of work done in the United States during the year represents a satisfactory increase.

Referring to the Bureau of Navigation reports again, the total tonnage of all classes of merchant vessels built on the Atlantic and Gulf coasts of the United States was 171,494, or about 59 percent of the total gross tonnage. About 26 percent was built on the Great Lakes and 13 percent on the Pacific Coast, the remaining tonnage falling to the Western rivers and Porto Rico. Conditions during the last year were, therefore, somewhat the same as a year ago, when the Atlantic and Gulf coast yards produced about 65 percent of the total merchant tonnage, and the Great Lakes yards about 22 percent. Of the total number of ships building in the United States during 1912, 105 were steel steamships aggregating 155,743 gross tons, or about 53 percent of the total tonnage built.

The greatest volume of work in an American shipyard was turned out by the Newport News Shipbuilding & Dry Dock Company, where twelve vessels, aggregating 61,242 gross tons and 62,100 indicated horsepower, were launched. The merchant work credited to this yard includes the steamships *Evelyn* and *Carolyn*, both of 3,141 tons; the Clyde Line steamer *Lenape*, 5,170 tons; the *Adeline Smith*, of 2,168 tons, and the *Peter H. Crowell*, 3,100 tons, besides car floats, tugs and smaller vessels. For Government work the Newport News yard has launched the battleship *Texas*, 28,367 tons; the destroyer *Fanning*, 755 tons; the submarine *Tuna*, 500 tons; the revenue cutters *Miami* and *Unalga*, of 750 tons each, and the naval collier *Proteus* of 12,000 tons. The Newport News yard also has under construction the collier *Nereus* and an ammunition lighter for the United States Government, a cargo and passenger steamer for the New York & Porto Rico Steamship Company, an oil steamer of 5,100 gross tons for the Texas

Steamship Company, and an oil carrier of the same tonnage for the Southern Pacific Company, besides two large passenger and cargo steamers for the Matson Navigation Company, San Francisco. A smaller steamer of about 3,000 gross tons is also in hand.

The American Shipbuilding Company, the Maryland Steel Company and the New York Shipbuilding Company each turned out over 30,000 tons; the American Shipbuilding Company, the largest Lake shipbuilding concern, being credited with thirteen vessels, aggregating 38,015 tons, including the steamers *City of Grand Rapids, See* and *Bee*, four large Standard Oil barges, four medium-sized freighters and other smaller ships. At the Maryland Steel Company's yard two of the American-Hawaiian steamships, the *Minnesotan* and *Dakotan*, were completed, besides two naval colliers, the *Orion* and *Jason*. This yard has in hand six other American-Hawaiian steamships. At the New York Shipbuilding Company the naval work includes the destroyer *Jarvis*, two tugs, a Chinese cruiser and an Argentine battleship, while for merchant work they have completed three large oil steamers, two merchant colliers and a large river steamer, besides smaller vessels. The naval work in hand at this yard includes the battleship *Oklahoma* of 27,000 tons and two destroyers. The merchant work in hand includes three oil tankers for the Standard Oil Company, an oil tanker for the Gulf Refining Company, the steamship *Congress* for the Pacific Coast Steamship Company, and a steel steamship for the Old Dominion Steamship Company. Work in hand at the Fore River Shipbuilding Company, Quincy, Mass., includes the Standard Oil tanker *Richmond*, with a capacity of 1,500,000 gallons, three steam trawlers, besides a large amount of government work, which includes the battleship *Nevada*, two destroyers, a submarine tender, several submarine boats and the Argentine battleship *Rivadavia*. The Fore River Company completed in 1912 the destroyer *Henley* and three large freight steamers, two of over 4,000 tons. The William Cramp & Sons Ship & Engine Building Company, has been occupied chiefly with Government work. Seven destroyers are now in hand and a submarine and the gunboat *Sacramento*. Merchant work in this yard includes a 10,000-ton steamship for W. R. Grace & Company. At Bath, Me., the Bath Iron Works has under construction three destroyers and a small passenger steamer for the Maine Central Railroad. The Harlan & Hollingsworth Corporation, Wilmington, Del., which is devoted exclusively to merchant work, has in hand two passenger steamers of 4,000 tons each and a steel ferryboat, besides an order for car floats from the New Jersey Central Railroad.

The volume of shipping on the Pacific Coast is not large, but there is considerable variety in the types of ships under construction. At the Union Iron Works, San Francisco, three steel lumber schooners are in hand, besides a Standard Oil barge and four submarines. A 12,000-ton floating drydock for the company's own use is under construction by the Seattle Construction & Dry Dock Company, Seattle. For Government work this yard has two submarine boats for the Chilian Government and two for the United States Government. The merchant work includes two passenger steamers for the Inland Navigation Company, a large steam yacht and a suction dredge of nearly 2,000 tons. Another yard on the Pacific Coast where considerable work is in hand is the Craig Shipbuilding Company, Long Beach, Cal., where four medium-sized steamships are being built and also a large steel dredge.

Only two navy yards—the New York and Mare Island navy yards—are equipped for building new ships. At the New York yard the battleship *New York* was recently launched. At the Mare Island navy yard the naval collier *Jupiter*, to be fitted with turbine engines and electric transmission, is nearing completion, while two river gunboats have been laid down.

On the Great Lakes thirty-five vessels were launched during 1912, and fifty-two vessels are now under construction for 1913 delivery. Nine freight steamers of the 1912 production were for coast service. The construction of large bulk freighters has decreased rapidly during the last three years, but as there are excellent prospects for a large movement of ore in the coming year it is quite probable that orders for such vessels will soon be forthcoming. The types of vessels built on the Lakes during the past year have varied more than usual, as the yards have been freer to take on special contracts.

DISTRIBUTION OF SHIPBUILDING IN THE UNITED KINGDOM

	1912.			1911.		
	Ves.	Tons.	I. H. P.	Ves.	Tons.	I. H. P.
The Clyde........	389	640,529	378,326	413	630,583	768,889
The Forth........	32	19,054	7,915	31	11,319	9,355
The Tay..........	28	17,388	10,400	31	17,303	14,770
The Dee, etc......	71	11,217	18,100	82	12,419	23,614
The Tyne.........	97	388,376	464,855	126	418,325	421,060
The Wear.........	82	309,934	191,806	86	286,834	193,343
Tees and Hartlep'ls	100	261,888	182,210	134	279,245	160,640
Mersey-Solway....	128	139,601	243,480	128	84,085	245,649
Humber...........	131	48,495	62,970	117	44,966	55,770
The Thames......	120	14,319	16,860	167	38,504	72,751
English Channel...	130	11,931	101,635	97	8,829	90,974
Bristol Channel....	39	3,761	170	36	3,050	985
Dockyards.........	4	54,085	.....	7	59,260	.....

Nearly all of the shipbuilding districts in the United Kingdom benefited by the widespread activity in the production of tonnage for the year 1912. Only the Tyne, the Dee, the Tees and Hartlepools and the Thames districts showed any decrease, and with the exception of the Thames these decreases were very slight. The Clyde shipyards head the list in the volume of tonnage produced, as has been the case in recent years. In spite of the remarkable increase in shipbuilding which was experienced a year ago the demand for construction in this district has not in any way fallen off; on the other hand, the record figures produced this year apparently represent the legitimate results of the natural growth of shipping. The year has undoubtedly been the best and steadiest year ever experienced from a business point of view, and the prospects for the continuance of this prosperity in the immediate future are excellent. Almost every conceivable type of vessel was built on the Clyde during the year, with screw steamers of moderate size dominating. Outside of the Cunard liner *Aquitania*, no unusually large ships are in hand in this district. Considerable attention has been given to motor vessels, and while there has been an apparent falling off in Government work, nevertheless a vast amount of marine machinery for Government vessels has been turned out. The total indicated horsepower of marine machinery produced on the Clyde during the year was over 878,000, or about two-thirds of all the horsepower produced in the English engine building works in 1912. John Brown & Company had not only the biggest output on the Clyde, amounting to 178,500 indicated horsepower, but this is also the greatest amount of work ever turned out by a single concern in one year. The next highest record in this respect was made by the Vulcan Company in Germany last year, where 166,250 indicated horsepower was produced.

The returns from the English shipyards resemble very closely the figures turned in at the end of 1911, the bulk of the tonnage, as usual, being produced on the Northeast coast. Although there was a slight decrease in the Tyne district in 1912, a large amount of turbine and engine work was produced, and the prospects indicate that a large share of Government engine work will fall to this district. In the Wear district the prospects are also good. Swan, Hunter & Wigham Richardson have now ready a new yard for the construction of small vessels. In the Thames district the closing of the Thames Iron Works marks another period of decay in the shipbuilding industry for this district.

First Long Voyage of Motor Ship Eavestone

It is quite fitting, as one of our readers has reminded us, that one of the first ocean-going motor-driven cargo ships should make her advent in United States ports at Savannah, Ga., since it was from this port, nearly a hundred years ago, that the little steamship *Savannah,* of 250 tons, sailed to make the first voyage of a steamship across the Atlantic Ocean. The *Savannah's* voyage from Savannah to Liverpool took twenty-five days, and at that time it was conceived hardly possible that a ship propelled by a steam engine could be built that could carry enough coal to propel her across the ocean, to say nothing of carrying freight. Now almost a century later there has come into the same port a type of ship which marks another epoch in ocean transportation, as she is propelled by an internal combustion engine and carries in her double bottom sufficient fuel to carry the ship practically around the world without reloading, and, at the same time, carries a cargo equal to that carried in her sister steamships.

The arrival of the motor ship *Eavestone* has, therefore, aroused considerable interest among naval architects, shipbuilders and marine engineers. The vessel itself is a single screw ship displacing 4,500 tons, with a length of 276 feet and a beam of 40 feet 6 inches. She is equipped with a 1,000 horsepower Carels-Diesel engine designed to give the ship a speed of 9½ knots. The hull was built by Messrs. Sir Raylton Dixon & Co., Middlesbrough, and the engines by Messrs. Richardsons Westgarth & Co., Ltd., Middlesbrough, in conjunction with Messrs. Carels Bros. Ltd., Ghent, Belgium. The vessel forms one of the large fleet of Messrs. Furness, Withy & Co., and as she is the first large British-built and British-owned Diesel-engined motor ship, the results of her first long voyage across the Atlantic have been awaited with interest.

The first trip which the ship made was from West Hartlepool to Antwerp and return. Then she sailed for the Baltic Sea with a cargo of coal, returning with a cargo of lumber. Starting on her first long voyage from West Hartlepool, she carried a cargo of coal to Barcelona, Spain. From Barcelona to Pomaron, Portugal, she ran light. At Pomaron she took on a full cargo of Pyrites ore and sailed for Savannah, Ga. This latter voyage covered a distance of 3,701 nautical miles and was completed in 18 days 18 hours. The total oil fuel consumed for the passage was 73 tons 10 cwt., the average daily consumption being 3 tons 18 cwt., making an average fuel consumption of .46 pound per shaft horsepower hour.

After loading a cargo at Savannah, the ship sailed for Norfolk, Va., to take on a cargo of fuel oil. A speed of 9½ knots was obtained on this trip, the engine developing 1,000 shaft horsepower at 92 revolutions per minute. After taking on 165 tons of fuel oil, which was pumped into her double bottom, she sailed from Norfolk, January 7, for Rotterdam, London and West Hartlepool, when she will return again over the same course via Barcelona, Pomaron and Savannah back to Norfolk, completing the entire voyage of over 8,000 miles without taking on any additional fuel.

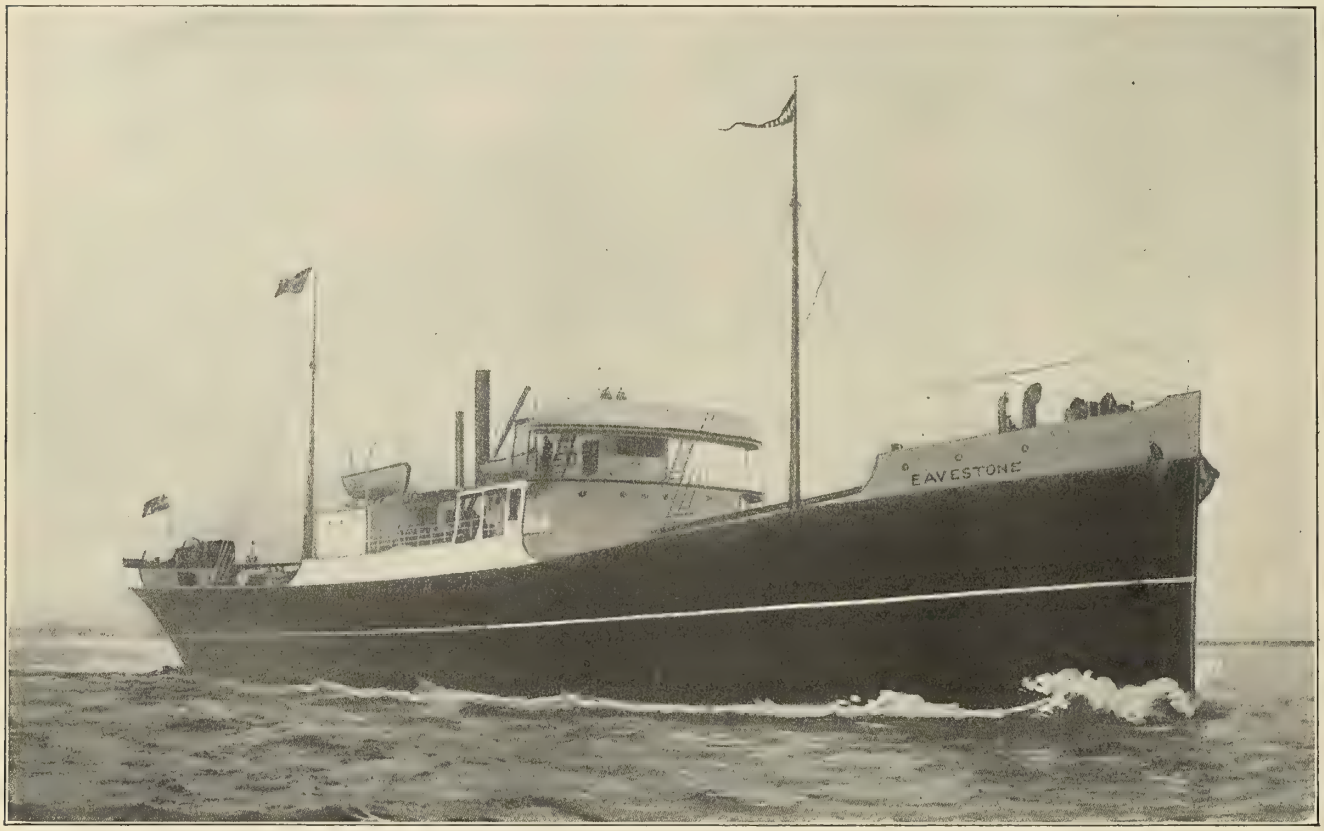


FIG. 1.—MOTOR SHIP EAVESTONE FITTED WITH 1,000 HORSEPOWER CARELS DIESEL ENGINE

The economy of this type of engine seems quite well established from the record of fuel consumption on this long voyage, and the reliability of the engine is also evidenced by the fact that the voyage was made without a single stop, the engine meeting every requirement of continued service. After the ship had finished her voyage, however, trouble was experienced by the cracking of a cylinder head and the cracking of a piston. The cylinder heads in this engine were made of cast steel to meet Lloyd's requirements, although we understand it had been the custom of the Carels Company to use in all their Diesel engines a special grade of cast iron for the cylinder heads. Since this experience with the cast steel heads in the *Eavestone's* engine, it is understood that the cast steel heads will hereafter be replaced by the special grade of cast iron advocated by the builders and which has given satisfactory results in their stationary engines in service for a number of years.

The cause of the cracking of the piston is attributed partly to defective water circulation through the piston, a fault which it seems could easily be avoided by careful supervision when the engine is starting up, as it should be quite possible to ascertain the temperature of the circulating water and thus determine whether all parts are being properly cooled. As the circulating pumps are driven off the main engine, and the water is taken first from the main air compressor into the pistons, then to the crosshead guides and main bearings, thence flowing to a tank in the bilges, circulation, of course, is not established until the main engine has started. Perhaps trouble from this source might be avoided if independent circulating pumps were used, so that the water circulation could be established before any attempt was made to start the engine, since the engine itself operates on air for only a very few revolutions, and begins to operate on oil almost as soon as it is started.

A general description of the *Eavestone's* engine was published in our October, 1912, issue, but a more detailed description of the valve gear arrangements is now possible after

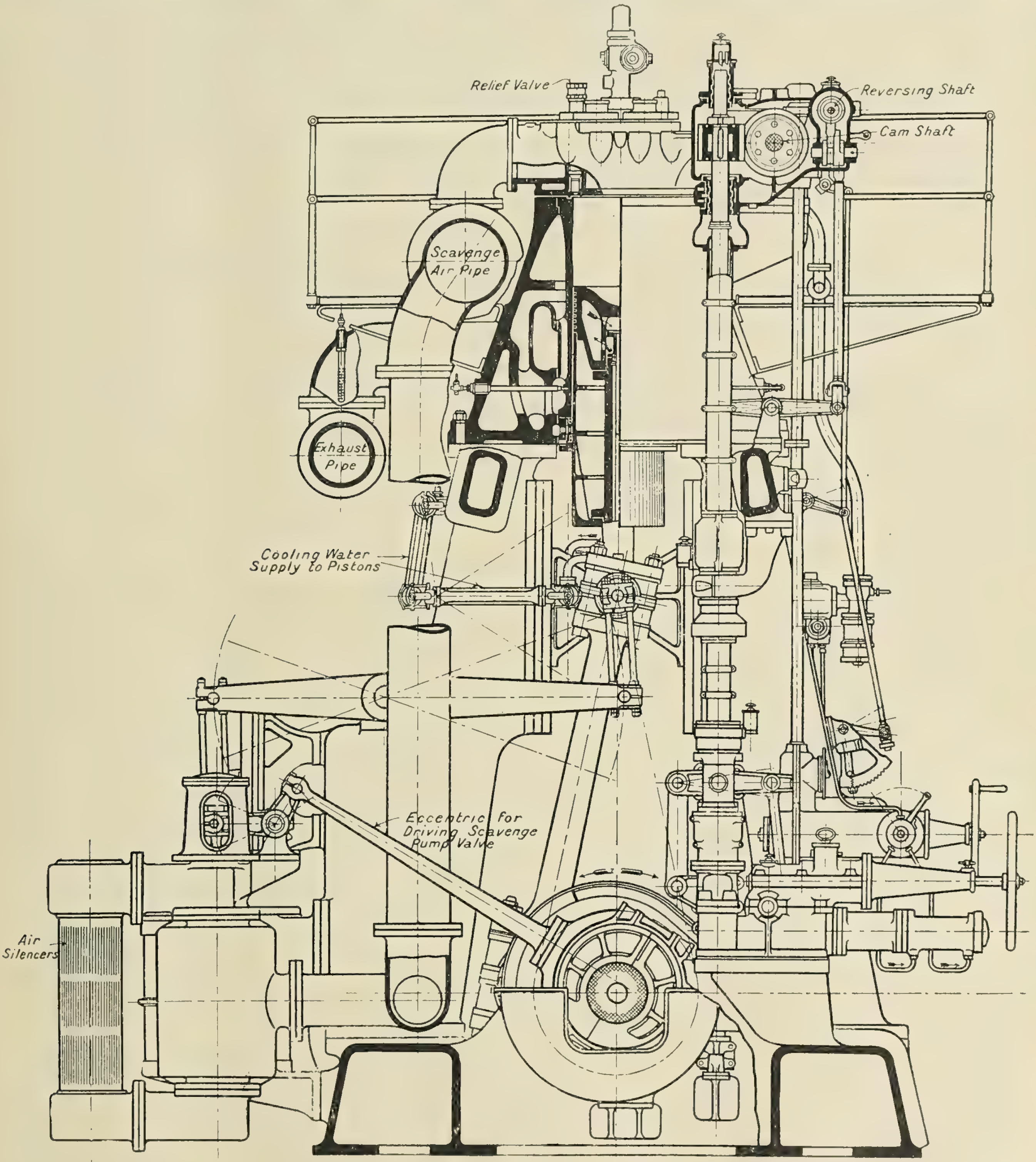


FIG. 2.—SECTIONAL VIEW OF EAVESTONE'S ENGINE

(Engraving Reproduced from *The Engineer*) observation of the engine in service. The engine is a four-cylinder two-cycle Carels engine with cylinders 20.1 inches diameter and 36.22 inches stroke. Its simplicity in design permits of easy access to all working parts, and its strong resemblance in external appearance to the ordinary triple-expansion steam engine undoubtedly goes far to overcoming the prejudice of marine engineers towards the advent of internal-combustion engines on board ship. Besides the construction of the rigid bedplate, heavy box columns, connecting rods, crossheads and double guides, which are practically identical with steam practice, the similarity between the Carels engine and the steam engine is carried out still further by the fact that its

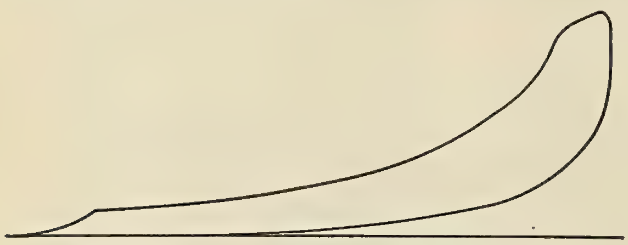


FIG. 3.—INDICATOR CARD FROM CYLINDER NO. 3 OF EAVESTONE ENGINE. COMPRESSION 460 POUNDS PER SQUARE INCH

circulating water pump, bilge pump, fuel pump and air pumps are all actuated by levers from the main engine's crossheads.

The construction of the cylinders, cylinder heads and pistons will be understood from the sectional drawing (Fig. 2) which is reproduced from *The Engineer*. The cylinder has a separate liner inserted with the exhaust ports extending around its periphery at the lower end. An exhaust belt of ample area extends around the cylinder in the water space through which the exhaust gases pass to the main exhaust pipe. The pistons are built in two sections, the top piece is carried by a shoulder on the piston rod, and the bottom piece, which serves to cover the exhaust ports while the piston is at the top of its stroke, is carried at its lower end by another shoulder on the piston rod. A stuffing box at the lower end of the liner serves to prevent leakage of any exhaust gas past the piston into the engine room.

All of the valves are placed in the cylinder heads. There are four scavenging valves, a fuel oil injection valve, an air starting valve and a relief valve in the head of each cylinder. All of the valves are operated through levers actuated by cams carried on a shaft which is supported by bearings on the cylinder jackets. The cam shaft itself is actuated by means of a vertical shaft and spiral gears at the center of the engine connecting the cam shaft to the crank shaft. A maneuvering shaft, which runs alongside the cam shaft, serves to operate the rollers of the valve levers, so that they are brought into contact with the proper cams for running the engine either ahead or astern.

The valve gear appears at first sight to be complicated, yet when seen in practice the operation of the gear proves quite simple. All of the moving parts have a comparatively slight motion, and the possibility for any part failing to perform its function is very remote. Four scavenging valves in each cylinder, for instance, are operated by two valve levers, for each of which there is a single cam, the relation of the movement of these cams to the crank shaft being changed for ahead and astern rotation by the rotation of the cam shaft itself to an angle of about 30 degrees by lengthening through a servo motor the vertical shaft connecting the crank and cam shafts. For both the fuel injection and the air starting valves there are two cams for each valve, and for the operation of these valves the maneuvering shaft comes into play. The rollers on the valve levers do not come in contact with these cams, but are held well above them, and an intermediate or roller-raising lever is inserted which in turn is controlled from the maneuvering shaft. The maneuvering shaft is moved longitudinally, and the intermediate fuel injection and air-starting levers are brought into line with the fuel or air-starting cams for either ahead or astern motion. Rotation of the maneuvering shaft causes the intermediate levers to descend upon the proper cam and still further rotation of the maneuvering shaft with its cams forces a wedge piece through a roller and spindle, establishing or withdrawing direct contact from the main cam shaft to the valve levers, as may be required when the engine is being operated on either air or oil.

This valve mechanism, especially the wedging action whereby the starting air is gradually cut out and the fuel oil gradually cut in in the different cylinders of the engine, is an ingenious arrangement and one which is always definite in its action, resulting not only in smooth running of the engine with the avoidance of shocks when starting or reversing, but also reducing the human factor in handling the engine to a minimum; in fact, the entire control of the engine is by means of one wheel and two levers, one lever controlling the fuel and the other the reverse changes. It was demonstrated that the engine could be operated from full speed ahead to practically one-third speed, or, to be exact, from 92 revolutions per minute to 35 revolutions per minute, by a slight movement of the lever which controls the fuel pumps. Reversing from full speed ahead to full speed astern takes less than eight seconds, and the speed of the engine can be brought down to a minimum of 35 revolutions per minute. The engine runs with practically no vibration and with very little noise. When the engine has been lying idle for some time it is occasionally found necessary to resort to a fuel with a lower flash point, such as kerosene (paraffin) when starting. This was found necessary while the ship was in Norfolk, when it was thought that full compression was not obtained on account of the wearing of the main bearings after the long voyage across the Atlantic. As soon as the engine was started, however, no further difficulty was found in firing the heavy fuel oil. An indicator card is shown in Fig. 3, taken when the engine was running at 92 revolutions per minute with a compression pressure of 460 pounds per square inch.

It will be recalled from the article published in our issue of October, 1912, that the main auxiliaries were driven off the main engine, the only independent auxiliaries operated by steam from the coal-fired donkey boilers were the winches, steering gear, donkey pump, condenser circulating pump, steam ballast pump, an evaporator and a spare air compressor of 60 horsepower. While running at sea the donkey boilers are shut down except for driving the generator or for steam heat. The steering gear is then run by compressed air at 35 pounds pressure, supplied by the main compressor to a storage tank in 'tween decks. The steam circulating pump for the condenser is also shut down and circulating water from the main engine pump is used. Ordinarily the main air compressor, which in this case is a multiple stage Reavell reversible compressor coupled directly to the main engine, is designed to deliver more air than required for fuel injection, so as to maintain sufficient pressure in the receivers to allow maneuvering without starting up the auxiliary steam-driven compressor. On long voyages, where the main compressor is in operation all the time, this would mean a waste, but here economical use is made of the excess air in the steering engine without effecting the results attained by the main engine.

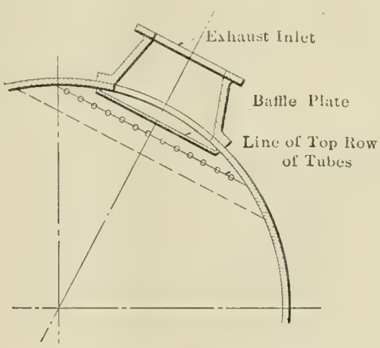
Derrick-Wrecking Steamer Mauch Chunk.—The Harlan & Hollingsworth Corporation, Wilmington, Del., recently launched the derrick-wrecking steamer *Mauch Chunk*, a steel vessel 118 feet long by 31 feet beam by 12 feet 9 inches depth, which that company is building for the Central Railroad of New Jersey.

Letters from Practical Marine Engineers

Incidents Relating to the Design, Care and Handling of Marine Engines, Boilers and Auxiliaries; Breakdowns at Sea and Repairs

Condenser Trouble

Some time ago a certain paddle steamer gave great trouble with her condenser tubes. The boat in question had been but recently launched and was fitted with an ordinary cylindrical surface condenser. After about three weeks' running the trouble began to manifest itself, and thereafter continued at regular intervals of about ten days, when a number varying between two and twenty-two tubes had to be renewed. Naturally, an inquiry was set on foot and the manufacturers had to supply an entirely new set of tubes. This procedure, however, did not abate the trouble one jot. As the condenser had by this time been inspected for leaks, a fairly large number of times it was noted that the faulty tubes were invariably



SECTION OF CONDENSER, SHOWING LOCATION OF TUBES

in the top three or four rows, and the expedient was resorted to of replacing these tubes with mild steel rods. After this had been accomplished the trouble ceased, hence one would infer that the cause of the evil was due to having the top row of tubes too near the baffle plate, as indicated in the accompanying sketch (not to scale). Had the top row of tubes originally been kept, say, six inches lower down, as indicated by the dotted line, in all probability the trouble would have been avoided. Naturally the substitution of the steel rods brings about a slight decrease in efficiency of the condenser, but it more than balances the money spent on renewing tubes. The above anecdote shows the necessity of careful design of the condensers. "ISON."

A Neglected Sea Danger

Since the *Titanic* disaster the question of safety at sea has been one of the leading topics of discussion in the marine circles of almost every nation. While attention is thus attracted to the overcoming of dangers at sea it should be remembered that besides collisions and stranding there is another equally formidable enemy to be coped with—i. e., the danger of fire. In expert circles the vexed question is asked as to whether the favorable opportunity of the international discussions in regard to the increase of security at sea will not also allow the consideration of the question: "To what extent can the danger from fire on board ship be limited?"

The building requirements of the German Lloyd Company, and accordingly of the whole of the sea-trading industry, in connection with the means for the prevention of the spread of fire on board ship, are limited to the provision that ships over 100 meters in length should be provided with partition walls at distances not exceeding 40 meters. As, however, it is not stipulated that these partitions should be rendered fireproof, they are, in fact, not actual "fireproof partitions," but mere divisions which can prevent the spread of the smoke until such time as they themselves become ignited. They therefore only deserve to be called "smoke partitions." If one compares the police building regulations for public and private buildings on land with those for the building of ships, the insufficiency of the latter will immediately be recognized.

In order to afford effective security against the fatal spread of a fire on board ship it is necessary that the ship be divided into several fireproof compartments separated from one another. With this arrangement the fire would remain in *one* part, passengers and crew would find protection in another part, and the ship would be guarded against total destruction. There are also a few very important parts of the ship which require to be protected by fireproof walls and decks; these are the postal rooms, bullion and cash rooms and the wireless telegraph room.

The system already existing for the watertight division of rooms may also be adopted for the division of fireproof compartments, as a few of them can be rendered fireproof. As ships are now constructed, a fire could in a very short space of time spread over the whole ship, and so quickly that there might not even be time for the passengers to escape with the boats.

If anyone had undertaken before the *Titanic* tragedy to suggest that the unsinkable qualities of ships should be improved, and that boats should be provided for all on board, he would have preached to deaf ears. No one would have taken his proposal seriously and deliberate shrugs of the shoulder would have been the answer. After the sinking of that ship all the world regards these securities as a matter of course.

May we never have to wait for a fatal fire on board ship before we realize that ships must be rendered not only unsinkable but also fireproof. Compared to the terrible results of a catastrophe through fire on board a passanger steamer, even the awful calamity of the sinking of the *Titanic* might appear insignificant. D. AUGER.

"When a Dutchman is Not a Dutchman"

No doubt there is a great deal of unnecessary, and, in the end, unsatisfactory work done in connecting or making up that part of a ship's construction which involves the use of steel castings, such as stern posts, hawse pipes and other bulky parts. The fault, however, does not always lie in the casting, but in the lack of foresight in the design.

There is bound to be unavoidable variation in the structure of a ship, and steel castings are not all uniform. To overcome this uncertainty in general practice, heavy chipping surfaces are provided, which are in turn chipped off in the field with hand air tools. Those who are familiar with this class of work (and it is common in all shipyards) will appreciate the slow, laborious rule-of-thumb methods that have to be resorted to before the scarph or lap is ready for bolting or riveting. In many cases the "spare" to be chipped off on both joining surfaces (whose area is often 4 to 6 square feet) will be a depth of solid steel 1½ to 2 or 3 inches. Now to chip this off by eye with hand air tools, and often on unsteady platforms high above the ground, is a slow and expensive operation; so is the work of the fitters with the assistance of the rigging gang, who must raise and lower these heavy parts until a satisfactory fit is finally secured.

A metal to metal fit is, of course, required, and a metal to metal fit is secured, in spots at least, as chipping, skillful though many of these workmen are, is far from the machined surface fit that is really aimed at in the design. A stopwater of variable thiskness, well soaked with thick red lead, is the "finishing touch," as the casting is pulled to its line and riveted up. Seeming impossibilities are overcome daily in shipyards as a matter of course, but they are expensive, and when finished are not what the design intended. This is not the workman's fault and not the fault of the casting. The trouble lies in the design.

To eliminate these conditions where possible is what should be done. Our hull men can learn a lesson now and then from their engineering brothers, and one in particular on this class of work. Where the engineer recognizes that a fit between two members is next to impossible, he wastes no valuable time fighting the inevitable, but allows a certain space to exist and goes ahead working above and below this imaginary line, established on a good common sense basis, and finishes his work accordingly. When the assembling comes, a finished liner of proper size and material is inserted, and the chipping, fitting and numerous other operations and delays never occur, due to the very reasonable idea that overcoming near impossibilities may be possible, but are not efficient or economical.

Sectional parts of cast steel structure can be treated in a similar manner in many cases (where it is not generally done) with good results.

The "dutchman" idea comes when the liner is an afterthought, but when it is incorporated in the original design and its usefulness recognized, it assumes the dignity of a "liner." This elastic spacer occurs in no less an important location than between the very life of the ship itself, the engine, and the foundation upon which it works. Enough said. Why not adopt a good thing that has proven its worth through years of service and design, with a clearance that allows machined surfaces and a finished liner? E. B. W.

The Burning of the Sarah Sands

The burning of the *Sarah Sands* is an event which claims a record both in military history and in the annals of adventures on the deep. It would be difficult for imagination to depict anything more appalling than the scene presented by a ship on fire, freighted with hundreds of human beings, and drifting on a desolate sea, apparently to certain doom. Not a ship was sighted from the hour of the burning of the *Sarah Sands* until her arrival at Mauritius, and had she foundered (taking into consideration her position, 1,000 miles from land, and out of the track of ships) the affair never would have come to light, and, like the loss of the *President,* would have remained a mystery to the end of time. Several bottles containing statements to the effect that the vessel was on fire were thrown into the sea. None of them was since recovered.

The *Sarah Sands* was one of the earliest iron screw ocean steamers. She was built at Liverpool in 1846, and measured 1,400 tons gross, 182 feet long, 33 feet broad and 32 feet deep. The hull was divided into three watertight compartments by two iron bulkheads, and these proved to be her salvation, as will be seen further on. The machinery, made at the Clarence Foundry, Liverpool, consisted of two oscillating cylinders, each 50 inches in diameter, 3 feet stroke, 300 indicated horsepower, working upwards to the crankshaft, which was coupled direct onto the tunnel shaft, a most unusual practice in those early days.

This vessel sailed on her first voyage from Liverpool to New York on Jan. 20, 1847. She continued on this route (in conjunction with the Red Cross Line of American sailing packets) until December, 1849, then for two years traded between Panama and San Francisco. From that service she proceeded to Sydney, owing to the gold fever (as it was termed) prevailing in Australia. From there she returned to Liverpool, and later, in 1854, she went on the Canadian route, from which she proceeded to the Crimea under charter to the British Government. During the Indian Mutiny, in 1857, the *Sarah Sands* was again chartered by the British Government, and sailed for India from Portsmouth on Aug. 15 of that year, having on board the headquarters of H. M. 54th Regiment—about 350 rank and file.

THE ILL-FATED SARAH SANDS, ONE OF THE EARLY IRON SCREW OCEAN STEAMERS

On the 11th of November, when 1,000 miles from any land, smoke was observed to issue from below. A cry of "Fire!"—that most horrible of all cries at sea—was raised. Measures were taken by the chief officer and the carpenter to discover the cause of the alarm, and, upon lifting the hatches, the smouldering materials stowed in the after part of the vessel burst forth into a blaze. The smoke so overpowered them that they were compelled to make a precipitate retreat to escape suffocation. All further efforts in this direction were then useless, and to make matters worse the crew (who had been mutinous and troublesome to the captain and officers ever since leaving England), with a few exceptions, seized two of the best boats and made off, leaving the others to their fate. The first thought of the commander was to secure a compass and a chart. Orders were given to take in all sail, and after much difficulty, owing to the few hands left on board of the crew, the ship was hove to. The fire engine was put to work, but several streams of water produced no appreciable effect on the flames, which now mingled with the clouds of smoke in the saloon and made a most terrifying scene. There were five ladies on board; they were hastily put into a boat, provided with fresh water and such provisions as could be obtained, and lowered to the water. At about the same time Private William Wiles and a sailor, Quartermaster Richard Richmond, at the risk of their lives, struggled through the dense mass of smoke which filled the saloon and saved the colors of the regiment. These colors are now in the Norwich Cathedral. It is due to men of the 54th Regiment to say that they maintained perfect order during the whole period of the fire, which continued more than fourteen hours. In no instance was it necessary to find fault with any of them. The *Sarah Sands* carried a large amount of powder and ammunition stowed in two magazines; the starboard one was quickly emptied, but on account of the mass of hot suffiocating smoke the port one was found most difficult to reach.

Nevertheless, volunteers were found to attempt to clear this magazine. Major Hughes was the first to descend and pass up a cask of ammunition. His example was followed by several others, and most of the dangerous contents were brought on deck and thrown overboard. Two large barrels of powder remained, however, which no exertions could reach. Those in the boats were told to pull beyond the reach of danger, as in the event of an explosion the foundering of the ship would almost certainly take place. At about 9 o'clock P. M. the fire burnt through the upper deck and set fire to the jigger rigging. Soon the mast fell with a crash over the ship's side, and the rest of the rigging was cut away in order to release the burning mast, which was causing the stern of the vessel to veer round into the wind. The expected explosion now took place with fearful effect. The after cabins and saloon (or what was left of them) were blown yards into the air, and a part of the port quarter was blown out. The ammunition exploded with the brilliancy of multitudinous sky-rockets, and according to a letter in the *Times* of that day gave the vessel the appearance of a volcano in eruption.

The concussion caused by the explosion was so great that the stern of the steamer dipped, and for a moment was under water, and everyone believed she would settle down with all on board. In this apprehension rafts had been rapidly constructed of spars and any timber that came at hand; two of them were set afloat, and a third was left across the deck to be lowered in the last extremity.

The troops were still pursuing their arduous work and, to their credit be it recorded, not a man attempted to rush upon the rafts. The saving of the vessel and the hundreds of lives which she carried was unquestionably due to the discipline and courage of the officers and men. The deck was now cut through with axes, and men lowered to throw water on the burning mass and so keep the fire in check. It was next observed that the iron sides of the vessel were becoming red-hot, a discovery fearful enough to fill the bravest with dismay. Every particle of wood in the after part of the ship was destroyed, and as the flames shot up from below a blue vapor arose which hung over the red-hot iron underneath. Finally, at 9 A. M. on the 12th, after fourteen hours of desperate work, the fire was under control, and the feeling of suspense which every one on board must have suffered was in a measure relieved. The ship herself, however, was in a fearful condition; there was about 20 feet of water in the after compartment, in which were the water tanks, and each time the vessel rolled they were driven with such violence against the iron plates as almost to smash them to atoms; they were in a short time secured and further damage prevented. The heat had been so intense that the glass in the scuttles melted and hung down like icicles.

There is no doubt that if the *Sarah Sands* had been constructed of wood instead of iron she would have been lost; and the fact that she was fitted with three iron watertight bulkheads (the inside of one having always been kept wet by the soldiers) also contributed largely to her safety.

This fire and the ultimate saving of the ship did much to remove the prejudice then existing towards iron vessels. Shortly after the fire was put out the boats were picked up; fortunately no casualties had happened on board of them. The commander also allowed the sailors who were in the boats to return on board, although he observed they ought to have been cast adrift. As the vessel was very light and rolling and shipping seas where the port quarter had been blown out, two chains were passed round the stem to strengthen it, and canvas and anything that could be obtained was used to fill up the opening, and the leak was thus stopped. The ship, after the fire, was steered by ropes attached to the rudder head. Six men sat on planks on one side and six on the other, pulling and letting go as required. Under such conditions was the hull of the *Sarah Sands* navigated nearly 1,000 miles to the island of Mauritius—we believe a feat of seamanship unparalleled in the annals of any nation.

To add to the miseries of those on board the provisions and water were nearly all destroyed, and all hands were put on very short rations until Mauritius was reached, which happy event took place on Nov. 25. From there the 54th Regiment was transferred to another vessel and sent on to Calcutta. The *Sarah Sands* was temporarily patched up and returned to England under sail. She was then thoroughly repaired, her engines removed, and she sailed for Bombay as an ordinary sailing vessel, but ran ashore at the mouth of the Thana River, and was so badly damaged that she was abandoned.

Francis B. C. Bradlee.

Blemishes on Machine Work

No matter what our grade of intelligence may be, or what the nature of the work we perform for a living, we all like to see things that look pretty. It is for this reason, maybe, that we criticise blemishes and those who make them. Even in the cases where the blemishes do not in any way impair the strength, and where the cause of the same is beyond the control of anyone, we criticise just the same. All of the arts and trades have the same experiences, but the case of the rocker arm pin as described herein comes home to the marine engineer and the marine engine builder.

The incident occurred during the building of our "New Navy," which, of course, was quite a number of years ago, and a certain torpedo boat has served its country and gone to the scrap pile, yet the same story in substance is oft repeated to-day. When dealing with blemishes complications are likely to arise, because it requires rare judgment sometimes to distinguish between blemishes and defects. It would be expected that the builder, wherever possible, would say "repair," while it is equally certain, as experience has shown, that the Government inspector would say "scrap." Hence, it follows that the builder is frequently "up against it" and he is compelled to perform certain operations in the "dark," though these same operations may be of as great a value to the purchaser as to the builder.

One of the marine engine rocker arms mentioned above is shown in Fig. 1. These rockers were forgings with the pins *A* cut from the solid, as shown in Fig. 2. The holes *J*, *C*, *C* removed most of the stock, and the parts *D* and *E* were cut out, thus leaving a square pin, as shown in Fig. 3. Then the square pin was worked to an octagon and finally to the round to fit the brass templet in Fig. 4. To-day these pins would be turned by a special fixture on a lathe and the work done at a fraction of the former cost.

On one occasion when the pin had been cut down to within one-eighth inch of the finished diameter, a large slag hole *H* was opened up in the middle of the pin. It looked mighty ugly, but really did not impair the strength of the pin enough to matter, as the parts were extra strong. At the same time, however, unless the appearance was made good, the entire forging, with all the work done on it, would be a total loss. Therefore, before the pin was inspected, the blemish was

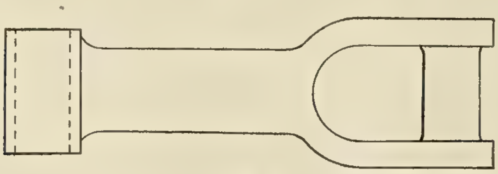


FIG. 1

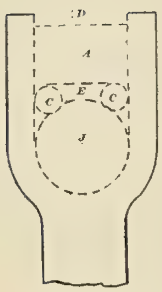


FIG. 2

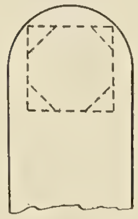


FIG. 3

FIG. 4

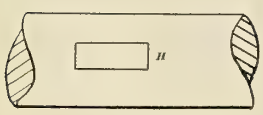


FIG. 5

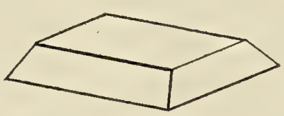


FIG. 6

cut out, as shown in Fig. 5, forming a rectangle in the solid metal. Then a "dutchman," as in Fig. 6 enlarged, was set in and the metal peened to a tight fit. A second peening was given the block just before the last filing operation. The final finishing was done with emery and oil, the cloth being drawn over both the pin and the block. It was impossible to detect any joints between the two parts. No doubt many of the readers of International Marine Engineering have had some unusual experiences with both blemishes and defects in marine engines. Can you not express your views on the subject? F. Webster.

Scranton, Pa.

Iron versus Steel

With the increase in physical properties of the materials of construction, the weights per horsepower of marine machinery have been greatly reduced, but the life of boilers made of high grade steel does not compare favorably with that of the old-time boilers built of iron. It is unnecessary to dwell on relative merits, or even to discuss the reasons for the change, but a glimpse at the cost of upkeep of the boilers built of charcoal iron and those of steel for the same size engines and the same working pressure would be of interest, and I think the following case bears out any argument which can be made:

In the year 1885 a lighter was built for the Long Island Railroad Company by W. & A. Fletcher Company, Hoboken, N. J. This lighter is fitted with a fore-and-aft compound engine, having cylinders of the following dimensions: High-pressure, 16 inches; low-pressure, 28 inches; stroke, common to both, 24 inches. The working steam pressure is 100 pounds gage. The boiler is of the well known and extensively used leg type, having the following dimensions: Width of front, 8 feet; length, 14 feet; shell diameter, 8 feet. There are two furnaces having a length of 6 feet 6 inches. The center leg of the furnaces is 5⅝ inches outside; the wing legs, 4⅝ inches outside. There is a combustion chamber 26 inches deep. The flues are of the following dimensions: Two flues, 13 inches diameter; two flues, 10½ inches diameter; two flues, 16 inches diameter, having a common length of 4 feet 6¾ inches. There is a wet-front connection 35¾ inches deep. The tubes are 3¼ inches O. D., having a length of 8 feet 6 inches. There is fitted a vertical steam drum in the center having a diameter of 48 inches and a height of 48 inches. The stack connection is 36 inches diameter and the height of front 8 feet 9 inches.

Here is a boiler that has been in constant service for twenty-seven years, and has the following record: The tubes and flues are as perfect as the day they were put in. The steam pressure has not been cut one pound. Mr. H. L. Des Anges, superintendent of the marine department of the Long Island Railroad, is, like the writer, a firm believer in the use of kerosene (paraffin) for boilers. The condition of this boiler shows the wisdom of the use of the above, for there is no scale and the water used is from the East River, and far from excellent. Can such a record be produced with a boiler built of steel and used in the same service?

The engine, I should have mentioned, is jet condensing. This boat is a lighter, but when a tug is undergoing repairs it is used for a tug, towing car floats. Again, it is used for the instruction of junior engineers, and from this it is evident that the machinery not only can, but repeatedly does, stand severe usage. There is no reason to doubt that the engines and boiler would wear out another hull, and should they be removed and installed in a hull used for towing, would show a fine record for years to come.

I am indebted to Mr. Ebsen, chief engineer of the W. & A. Fletcher Company, for the particulars of this boiler and engine.

New York. Charles S. Linch.

Strange Happenings

The following incident was related in a recent issue of the *Marine Journal* by its well-known editor, Captain George L. Norton:

"During the civil war the steamship *Saxon,* a transport in the service of the U. S. Quartermaster's Department, of which the writer was first officer, was sent north from Hilton Head, S. C., to have her machinery overhauled.

"Just before sailing the chief engineer and his two assistants, who, by the by, were his sons, took off the cylinder head, cleaned out the cylinder, the chief leaving the boys to put the cover back again, he in the meantime attending to some other duty. We left the dock the next day, and when passing through the Narrows a tremendous thump in some part of the machinery that was felt throughout the ship caused the chief engineer to shut off steam and the vessel to come to anchor. The shock came from the interior of the cylinder, so as soon as it cooled sufficiently to take off its cover, to the surprise and mortification of the chief and his assistants there was an S wrench found lying on top of the piston with one end of it flattened out as thin as a knife blade. This wrench was perhaps a foot and a half long with a slot in each end fitted to straddle the nut on the end of the piston rod, which held the piston in place. There was just space enough in the cylinder when the piston was on the up-stroke for the nut to clear the cylinder head. The wrench evidently got on top of the nut in some way and the blow flattened it out, but fortunately did no damage.—G. L. N."

Marine Articles in the Engineering Press

The Generation and Electrical Transmission of Power for Marine Transportation.—By William P. Durtnall. This paper was presented before the Society of Engineers and contains practically a history of the development of electrical transmission for propulsive purposes. After studying the conditions to which motive power for driving a propeller should conform, the suitability of electrical transmission for this purpose is thoroughly explained. Nearly all of the important installations of electrical transmission on board ship are described in detail. 5,750 words.—*The Steamship,* December.

Twin Screw Steamer Indarra.—The *Indarra,* a ship of 9,200 tons and 10,000 horsepower, has been built and engined by Messrs. Denny Brothers, Dumbarton, for the Australasian United Steam Navigation Company. The ship is a splendidly equipped passenger and cargo vessel. The machinery consists of two sets of quadruple expansion engines, with cylinders 26½, 38, 54 and 76 inches in diameter, with a stroke of 4 feet. Steam at a pressure of 210 pounds per square inch is supplied by seven single-ended boilers, working under Howden's system of forced draft. On her maiden voyage the vessel steamed with only five boilers in action at a speed of 16.68 knots. 9 illustrations. 1,450 words.—*The Marine Engineer and Naval Architect,* December.

Self-Discharging Collier.—By Frederick C. Coleman. William Doxford & Sons, Ltd., have recently built at the Pallion Shipyard, Sunderland, the steamship *Herman Sauber,* to the order of Sauber Brothers, of Hamburg. The vessel has a length of 315 feet between perpendiculars and a carrying capacity of 3,750 tons on a draft of 18 feet 9¼ inches. The service speed is 10 knots. The machinery, comprising triple expansion engines and forced draft boilers, is placed aft. Cargo is discharged by two conveyors, one on each side of the boat, running fore and aft below the holds, the cargo being fed to the conveyors by gravity. The conveyors are constructed on the Doxford patent system of continuous steel rope drive. They rise at a proper inclination through the machinery space and deliver the cargo in the stern of the vessel, where it is received on a second pair of conveyors and conveyed forward, and at the same time elevated to a suitable point of discharge. The feeding arrangement for the cargo to the conveyors is by means of drop feed doors spaced at regular intervals along the hold. When the vessel discharges on both sides from the two conveyors the cargo is delivered at the rate of from 400 to 800 tons per hour. The cost of discharging, including coal, oil and labor, is less than a farthing per ton. When a proper supply of receiving barges is arranged, the *Herman Sauber* can complete discharging in six hours for any coal except Welsh, which may take nine to ten hours. 6 illustrations. 1,800 words—*The Marine Review,* December.

Results of First Voyage of the Oil-Engined Ship Christian X.—The maiden voyage of the *Christian X,* which is a sister ship of the*Selandia,* previously described, of 7,400 tons displacement and 2,500 horsepower with twin screws, built by Messrs. Burmeister & Wain, Copenhagen, commenced July 28 and lasted 17½ days. The ship covered a distance of 4,627 nautical miles, the mean fuel consumption per indicated horsepower per hour being .370 pound, disregarding the small difference between the British and the Continental horsepower. Both the main and auxiliary engines worked well through the voyage. Rather thick and dry deposits were noticed on the portions of the cylinders and pistons not subject to rubbing effect. These were ascribed to the high percentage of sulphur and of mineral constituents in the fuel. For the same reason probably all the exhaust valves of the main engines had to be replaced and nearly all the valves and valve seats had to be turned true again. As regards the attendance, the air injectors had to be cleared of water almost every two hours, owing to the high humidity of the oceanic atmosphere. The discharge valves had to be kept in a throttled condition, and consequently did not keep tight. The valves thus necessitated a good deal of repair. On the other hand, the crossheads, the cranks, the guides and the bedplates of the two engines withstood the strains of the voyage quite well. During trial runs which lasted twenty-four hours, the fuel consumption per indicated horsepower per hour of the main engines worked out as .338 pound. The fuel consumption of the auxiliary compressors per indicated horsepower per hour was .365 pound. The total fuel consumption of the main engines and compressors during the twenty-four-hour trial was .367 pound per indicated horsepower per hour. The normal speed of 11.5 knots was reached during the trial. The average speed throughout the maiden voyage was 11 knots 1,200 words.—*Engineering,* Jan. 3.

The Story of the P. & O. Line.—An interesting account is given of the origin and development of the well-known P. & O. Line, including a description of the different types of vessels which have been entered in this service. All the earlier vessels were wooden paddle steamers, but as the science of shipbuilding advanced these were gradually replaced until the modern type of twin-screw steamer now employed in this line has been developed. The main fleet of the company now comprises 71 vessels of 543,961 tons built and building. In addition to these vessels there is a large number of tenders, barges, tugs and auxiliary vessels. 10 illustrations. 3,200 words.—*The Marine Engineer and Naval Architect,* January.

Boat Stowage and Davits.—The scheme of stowing and launching lifeboats on board ship, proposed by Mr. Charles Doxford, of Messrs. William Doxford & Sons, Sunderland, is described in detail. The davits are of the pivoted type and the boats are supported in chocks inboard. When the chocks are released the davits swing out and the boat is lowered by gravity. Friction brakes, acting on the boat falls, give the operator control of the launching. This arrangement can be made to accommodate two tiers of boats, one above the other. The upper tier is attached to longer davits, which swing the boat outboard of the lower tier boats when they are lowered. The lower tier of boats would be launched first and the upper tier would follow immediately. A diagram is given showing how this arrangement could be supplied to such a ship as the *Mauretania,* and boats having a capacity for all on board could be provided. 5 illustrations. 680 words.—*The Shipbuilder,* January.

Some Modern Systems of Ship Construction.—An outline is given of some of the main departures in recent years from the usual practice in ship construction. The first considered is the arch principle (Ballard patent) in which the upper part of the transverse section is treated as an arch. Above the molded depth line an arch is built which supports the deck and all probable top weights without any pillaring being necessary, but, at the same time, maintaining the buoyancy and draft of the vessel economically and affording a free hold. The second system discussed is the McGlasham, which embodies a second skin to provide safety against foundering in the event of collision. For a considerable portion of the length of the vessel the double bottom extends up the side to the weather deck. The capacity for water ballast of the side tanks thus formed is about three-quarters that of the bottom tank, extending from bilge to bilge. The next system described is the Harroway-

Dixon system, in which the distinctive feature is a cantilever frame combined with wing tanks. At about midway between the inner bottom and the deck the frame is bent through an angle of 45 degrees, thus forming a cantilever which supports the deck without the need of pillars, thus leaving perfectly clear holds. Other systems described are the well-known Isherwood system of longitudinal framing and the Monitor system, which is designed to increase both longitudinal and transverse strength, decrease rolling and also decrease the power required for propulsion. 13 illustrations. 4,300 words.—*The Marine Engineer and Naval Architect,* January.

Large Single-Deck Cargo Steamers.—By H. Bocler. Strictly speaking, a single-deck vessel would be one having a single continuous upper deck with no tier of hold beams and no long side-to-side erections on the upper deck. In practice the term "single-deck vessel" is extended to include ships with a tier of wide spaced hold beams, and with long erections, provided these do not extend over the full length of the ship. Thus the single-deck type with erections virtually merges into the shelter deck type when very long erections are adopted. The way in which the stringers and tiers of beams have been gradually eliminated since this type of vessel was first built is described in detail. The first real single-deck ship of considerable depth was the *Lincluden,* 312 feet by 42 feet 4 inches by 26 feet 3 inches, built by Messrs. Furness, Withy & Company at West Hartlepool in 1896. At the time of building she was considered to be a radical, if not dangerous, departure, but fears in this respect proved to be unfounded, and after that date many vessels were built, some having depths up to 29 feet 6 inches, in which reliance was placed solely upon deep framing unsupported by beams of any kind below the upper deck. As an example of the modern type of single deck cargo steamer a complete description is given of the *Hannington Court,* a typical modern cargo carrier, with a deadweight capacity of 8,500 tons on 23 feet 10½ inches draft. Her dimensions are: Length between perpendiculars, 400 feet; breadth, extreme, 53 feet 6 inches; depth, molded to the upper deck, 29 feet ¾ inch. This vessel has exceptionally clear holds free from pillars, except for the few necessary to support the hatch corners. In order to limit the size of the frames a tier of wide-spaced hold beams has been introduced. Apart from the deep hold stringer no side stringers are fitted except at the fore end. In conclusion, reference is made to the Isherwood system of construction as applied to such ships, and also to special forms of ships, such as the cantilever, the turret and trunk types. 9 illustrations. 2,200 words.—*The Shipbuilder,* January.

On Shearing Stress in a Ship's Structure.—By K. Suyehiro. This is a paper read at the recent meeting of the Japanese Institute of Naval Architects. Accepting the work of different investigators concerning the maximum shearing stress in a ship's structure as valid, the author finds that all conclusions as to the distribution of shearing stresses differ in many respects, and he has tried to throw some light on this subject. The analogous case of the shearing stress in a thin hollow cylindrical beam is taken as the basis of the investigation. Under the assumption that the inference deduced in the above case holds in a ship's section, the author has calculated the shearing stresses in an existing steamer. The paper describes how the calculations were made for the deck plating, bilge plating and double bottom. In his conclusions he calls attention to the well-known phenomenon that in not very rare cases the seams of bilge plating of iron ships, as well as of wooden ships, are subjected to the severest stress. This has been so far attributed to the shearing stress which is caused by heavy rolling when the neutral axis might happen to pass through the bilge plating. In the author's experience the weakness in bilge plating has sometimes been observed in boats of limited service, which have never been subjected to heavy rolling. From the stress diagram calculated it is seen that the shearing stress in the bilge plating does not fall off sensibly. Moreover, this plating, especially at the seams, is generally subjected to corrosion on the inside and to wear on the outside. The author suggests that these two causes may explain the weakness in bilge plating. It is also observed that the heavier the double bottom is constructed the more severely will the bilge plating be strained. Therefore, it seems that some distinction for the strength of bilge plating must be made in one way or another between ships having a double bottom and those with an ordinary floor. Also in the inner bottom and in the main deck plating the shearing stress is comparatively low. Therefore, double riveted seams may not be necessary for them. The British Corporation Rules have already given practical attention to this construction. The author points out that these inferences have been arrived at from a purely theoretical point of view. In actual ships a part of the shearing force will be taken by transverse members. The true quantitative values of shearing stresses can be found only by actual observations in a ship, and the author emphasizes the necessity of actual measurements of strains in ships for the further development of naval architecture. An approximate formula is given for determining the maximum shearing stress. 3 diagrams. 2,100 words.—*Engineering,* Dec. 27.

Shipbuilding Premiums in Russia.—A list is given of the shipbuilding premiums calculated per registered ton of the vessel's full tonnage prescribed in a law passed in Russia which came into effect Jan. 1, introducing premiums for Russian-built vessels subject to certain conditions. A premium is paid to shipbuilders within the Russian Empire for each vessel built by them for traffic in foreign waters and on the Danube with its tributaries, such vessels being of metal for merchant service, commenced after the publication of the law, and when completed registered as belonging to a Russian port. Further premiums are offered for indicated horsepower at the installation of new main or auxiliary engines, and for the repair and replacement of old boilers with fittings, etc. The premiums thus specified, after the lapse of ten years reckoned from the day of publication of the law, will be subject to an annual reduction of 6 percent. The law is to remain in force for fifteen years. 400 words.—*Engineering,* Dec. 27.

Progress in Naval Construction.—This article is an editorial review of naval construction in Great Britain during the year 1912. Attention is called to the increased time required and cost of recent battleships as compared with the construction of the *Dreadnought* in 1906, which went into commission fourteen months after the order was issued. At the present time, with the increase in size of both hull and machinery units, as well as on account of the boom in merchant shipping, two and one-half years should be allowed for the construction of the largest warships. The increase in cost is attributed largely, of course, to the increase in size and account is also taken of the increased cost of labor and material. One notable feature pointed out is the efficiency of the dockyard work, where there has been less delay than in some of the private yards. The total number of vessels launched in 1912 for the British Navy is 28; collective displacement tonnage, 167,495; the total horsepower of propelling machinery, 550,000. In 1911, 41 British warships were launched, aggregating 220,980 tons, with a total horsepower of 722,300. The total value of ships completed in 1912 is £4,000,000 less than in 1911. The main particulars of the various ships launched during 1912 are given in detail. A noteworthy feature mentioned is the uniformity and favorable character of the coal economy in the larger ships. At full power the consumption of coal was 1.7 pounds per shaft horsepower per hour. In almost every class of vessels the contract speed was exceeded on trial, frequently with an exceptional increase, although the rates of speed published in the daily press were in most cases grossly exaggerated. 5,500 words.—*Engineering,* Dec. 27.

Ten Thousand Horsepower Föttinger Hydraulic Transmission Gear.—Mention is made of the first Föttinger transmitter, described in a previous issue, which was fitted in 1909 on a small steamer which has since been in regular service in the port of Hamburg between Hamburg and Stettin, a gear which has proved reliable and accurate in action. The second transmission gear was fitted in a British boat in connection with gas engines and showed a maximum efficiency of over 88 percent. The 10,000 horsepower installation described was designed for use in a new liner for a German shipping company. It was designed for transmitting normally 10,000 horsepower at a speed of 850 revolutions per minute for the primary shaft and of 170 revolutions for the secondary shaft. This plant, set up in the builders' shops for tests, has undergone a continuous trial of two weeks' duration on a high load. The primary part of the transmitter was coupled direct to a Curtis A. E. G. Vulcan type turbine, and the secondary part was coupled to a shaft, the power being taken up by a large hydro-dynamic Föttinger brake. The steam turbine was run at different speed; reversing took place at different intervals for momentary action and for running reversed during varying lengths of time. The efficiency obtained was close up to 90 percent. Other installations of the same type of gear already under construction are also mentioned. 3 photographs. 900 words.—*Engineering,* Dec. 13.

The Shallow Draft Steamer Comte de Flandre.—Yarrow & Company, Ltd., of Scotstoun, Glasgow, has recently constructed for Lever Bros., Ltd., of Port Sunlight, a shallow draft river steamer intended to run on the Congo to bring oil from the upper reaches down the river. The hull is 190 feet long, 30 feet beam, 8 feet molded depth, built of galvanized steel. The boat is propelled by one set of triple expansion engines driving a single screw working in a tunnel fitted with the firm's latest type of patented hinged flap, which is arranged to work automatically, being balanced by balanced weights. The hull is divided into ten compartments, including the engine and boiler rooms, which are placed amidships. Forward of these are three cargo holds having a total capacity of 10,080 cubic feet, while aft there are holds having a capacity of 11,950 cubic feet. The deadweight cargo capacity is 250 tons, on a draft of only 4 feet 6 inches, and the estimated speed is 10 knots. Accommodation is provided for ten first-class passengers in separate single-berth cabins on the spar deck aft. Steam is supplied by two locomotive type boilers constructed by the North British Locomotive Company, Glasgow. The designs and construction of this boat were supervised by Messrs. Esplen & Sons, Liverpool. 5 illustrations. 725 words.—*The Engineer,* Dec. 27.

Proposed Rhine-North Sea Ship Canal.—The current year has witnessed the introduction of a scheme for the establishment of a great ship canal between the Rhine and the North Sea at Emden, so as to render the west of Germany independent of the Waal or Dutch section of the Rhine. At a conference held in the Banquet Hall of the Prussian Diet in Berlin on Nov. 15, two proposals were discussed. The first, or Herzberg-Taaks project, contemplates the construction of a ship canal from Wesel along the Dutch frontier to Emden, a large portion of the route consisting of uncultivated land and moorland. The second, or Rosemeyer project, provides for the canal to commence in the vicinity of Cologne at Wiesdorf, where the level of the Rhine is much higher than at Wesel, thus affording a natural fall from the Rhine to the North Sea at Emden. The scheme proposes a canal having a navigable channel of a depth of from 23 feet to 30 feet and a width capable of permitting one vessel to pass another in any place on a two-ship canal. It is calculated that the length of the waterway would be 168 miles, and that a considerable economy in time would be realized as compared with a route via the Waal to Rotterdam, while the time economy would be enormously increased as contrasted with shipments via Rotterdam and the Borkum Lightship to ports further north. Apparently these schemes meet with strong opposition from business interests, which it would be expected would benefit largely by such a canal. 1,300 words.—*The Engineer,* Dec. 13.

U. S. S. Fanning and *Jarvis.*—By Henderson B. Gregory. Reference is made to the descriptions of these two vessels which were published in previous issues of this journal. In this article is given trial data obtained from the official progressive, full speed and endurance trials. In accordance with the present custom of the Navy Department figures are given only of the speed and horsepower. 2 illustrations. 2,500 words.—*Journal of the American Society of Naval Engineers,* November.

Comparative Tests of Three Types of Turbine-Driven Forced Draft Fans.—By W. J. A. London. On account of the increasing use of turbine-driven forced draft fans in the navy, a series of tests was carried out at the works of the Terry Steam Turbine Company, Hartford, Conn., to determine the relative efficiency of three distinctive types of fans when combined with a standard Terry vertical turbine. The turbine was the maker's standard type "BV," being a duplicate of over fifty machines now in use in the navy. The normal rated capacity was 60 horsepower, with a throttle pressure of 250 pounds and a terminal pressure of 10 pounds gage at a speed of 1,400 revolutions per minute. The first fan had a rated capacity of 23,000 cubic feet of free air against 5-inch static pressure by water-gage at a speed of 1,400 revolutions per minute. The second fan was rated at the same capacity, but at a speed of 2,200 revolutions per minute, and the third fan was rated at the same capacity as the first one. A detailed description is given of the method of testing the machines, which is followed by tabulated results of the tests, including curves derived from this data. 10 illustrations. 1,800 words.—*Journal of the American Society of Naval Engineers,* November.

The Kingsbury Thrust Bearing.—By Lieut. W. W. Smith, U. S. N. In the thrust bearing recently invented by Mr. Albert Kingsbury, of Pittsburg, the load is uniformly distributed over the entire bearing surface, and the slippers are free to adjust themselves at slight angles to the collar, so as to glide or skim over the film of oil which adheres to and moves with the collar. In high-speed bearings a pressure of 500 pounds per square inch is being carried and in low-speed bearings 900 pounds. The safe maximum pressure which can be carried on these bearings is much greater than the above figures indicate, as a recent test on a turbine thrust bearing showed that a pressure of about 7,000 pounds per square inch could be carried without breaking down the film of oil. A description is given of the Kingsbury thrust bearings which were fitted to the turbines of the United States collier *Neptune,* which so far have given excellent results as regards both operation and repairs. The unit pressure on the *Neptune's* thrust bearings is 500 pounds, and the surface speed 4,300 feet per minute. This gives a large factor of safety or overload capacity which is a decided advantage. In conclusion, the faults which have been found to exist with the ordinary collar thrust bearings are pointed out, showing the desirability of the Kingsbury thrust bearing in comparison. 4 illustrations. 4,200 words.—*Journal of the American Society of Naval Engineers,* November.

Oil Engines for the Admiralty.—According to *Engineering* the British Admiralty have ordered oil engines for the propulsion of two more ships for carrying oil fuel for the supply of warships at sea. These ships are to be built at the dock yards. One set of machinery of the Fiat type will be constructed by Scotts Shipbuilding & Engineering Company, Ltd., of Greenock, and the other, of the Nürmburg type, by the Fairfield Shipbuilding & Engineering Company, Ltd., Glasgow.

New Books for the Marine Engineer's Library

Theoretical Naval Architecture

REVIEWED BY PROFESSOR C. H. PEABODY*

TEXT-BOOK OF THEORETICAL NAVAL ARCHITECTURE. Sixth edition. By Edward L. Attwood, Mem. Inst. N. A., Mem. Royal Corps Naval Constructors. Size, 5 by 7¼ inches. Pages, 511. Illustrations, 145. New York and London, 1912: Longmans, Green & Company. Price, $2.50 net.

This book, which may be considered as a standard for its class, was first published in 1899 and has now reached the sixth edition, which has been enlarged from the original 292 pages to 511 pages. The book was written for a particular purpose, and throughout the several editions the author has adhered definitely to that purpose, which has evidently been attained. That purpose, as stated in the original introduction, was to provide a text-book for students and draftsmen and to give preparation for examinations of the Science and Art Department (now the Board of Education). The increase in bulk of the last edition is in large part due to the secondary object, as evidenced by the fact that the space given to sample examination papers has been increased from 36 pages to 94 pages. At the same time the modest appendix of 13 pages, which dealt with such subjects as Simpson's rules and theory of launching, has been increased to 94 pages and includes such subjects as rolling among waves and the more intricate question of propulsion. The treatment of the book, especially as it refers to examinations, has impressed upon it a clearness and conciseness of expression that is notable, and, further, there are offered a large number of problems like those included in the examinations which are of the greatest advantage, especially to young men who depend largely on themselves. The appendix is not so adequately handled, for it treats in small space a number of problems which have unavoidably considerable complexity and do not offer satisfactory partial treatments; one may almost say that they should be treated adequately or else omitted. If the appendix is considered as a brief résumé of the subjects presented, and if the student may be expected to master them by reading the references which are recommended, then our criticism loses its edge, and yet the reading of original memoirs is a serious matter for students whose attainments are indicated by this book.

The author remarks: "For the bulk of those who study the subject of naval architecture, the only instruction possible is obtained in evening classes, and this must be supplemented by private study. The institutions in which systematic instruction in day courses is given are few in number * * * and students who can obtain the advantages of this training are comparatively few in number." This refers to the very extensive and efficient system of evening instruction in vogue in Great Britain, and which is fostered by all the technological colleges, which have evening classes frequently many times larger than their whole day registration. A liberal estimate is that an evening student, who is commonly an apprentice in some work, may accomplish a third as much in a year as a day student, and while evening classes are offered for work of any grade in demand, the result is that evening students cannot be expected to obtain much more than that proportion of the theoretical training given to the regular college students. This is no place for the discussion of the merits of a system of education which is wide in its scope and sound so far as it goes, but it is interesting now because it helps us locate the class for which this book is written.

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If another digression may be permitted, attention may be called to the large part in education played by formal examinations which are commonly set by persons not connected with the school, partly to secure breadth of view and practical application, and partly to insure a fair field and no favor in contests in which there are rewards like scholarships in the regular college courses. The sets of examinations in the appendix are a logical outcome of this system, and though less directly, the large number of problems scattered through the book may be credited largely to the same influence. A notable and most valuable feature of the book is the direct practical application of methods taught, and for such purpose, especially for students who must rely largely on themselves, there is no better method than the solutions of problems, so long as such problems do not degenerate into numerical computations so long or involved that the student loses his view of the principles. The problems in this book have been in large part selected from examination papers drawn up as explained above, and others were made up with the same object of practical applications, and where the subject matter of the text can be illustrated by brief problems one cannot ask for better. Nothing can be better than the following problem, which may have been taken directly from practice:

"A vessel of 1,792 tons displacement is inclined by shifting 5 tons already on board transversely across the deck through 20 feet. The end of a plumb line 15 feet long moves through 5¼ inches. Determine the metacentric height at the time of the experiment."

But the same commendation cannot be given the problem below:

"Ascertain the displacement and position of the center of buoyancy of a floating body of the length 140 feet, depth 10 feet, the forward section being a triangle 10 feet wide at the deck and its apex at the keel, and the after section a trapezoid 20 feet wide at the deck and 10 feet wide at the keel, the sides of the vessel being plane surfaces; draft of water may be taken as 7 feet."

To our mind this is an ingenious attempt to replace for the real problem of finding the displacement of a ship from its lines, an artificial problem involving the essential principles in a form short enough to be answerable during an examination. But it is in our opinion an instance of the impracticability of an attempt to be practical under the circumstances. The fact is that the proper training is to be attained only by working in customary methods on lines of a ship; such training can best be attained under an instructor, who is the only person who can determine whether the student is competent. We would not make so much of an item of this did it not to our mind stand for a principle. The matters that must be treated under the head of theoretical naval architecture are many and various. Some are simple enough to be evident to anyone with a knowledge of geometry, whether he has consciously studied that subject or not, and others for adequate treatment require the higher mathematics; and, further, some which are simple in general principles are long and involved in application. The greater part of theoretical naval architecture falls under one or the other classification, either the principles are simple and need little illustration by problems which in practical computation are long and difficult, or else the theoretical treatment is involved if not difficult, while the numerical computations are brief and seldom required in practice. Testing the competence of students by numerical problems leads to over emphasis of secondary matters or else to artificial problems of problematical value.

If our criticism is just, it is of the system and not of the author, and the practical application is that the student in this country who has not a governmental examination before him should solve problems with discretion for which he must rely either on his instructor or on some senior in the profession.

Of the eight chapters, five are given to the geometry of shipbuilding, such as displacement, center of buoyancy, metacenters transverse and longitudinal, and stability both statical and dynamic. All this is susceptible of treatment by comparatively simple methods, and much of it can be illustrated by problems. No better presentation can be asked than that of the book, especially if we keep in mind the class of students for whom it is written. Our only regret is that mechanical integrators cannot have larger notice, but that is one of the privations of the class of students so large in number that inexpensive methods must be used. The general application of such instruments in practice makes it most desirable that students should be familiar with them, and the fundamental principles are most clearly taught when students may learn them unclouded by long numerical computation.

The calculation of the weight of the hull is both very important and very difficult in practice, while the statement in any text-book is necessarily brief and inadequate. The calculations of weights and strength of details and fittings where possible demand a good knowledge of applied mechanics and strength of materials, and can have place in a text-book of naval architecture only in so far as such details are peculiar to a ship. Such, for example, is the discussion of riveted joints as used on ships. An item worthy of notice in this edition of the text-book is John's investigation of the strength of shaft brackets.

There is only one way of knowing whether a ship is strong enough for her service, and that is to send her to sea and watch her behavior. Fortunately, a ship is likely to show evidence of weakness or lack of stiffness long before there is real danger of failure, and modern ships seldom if ever are lost at sea on account of structural weakness. Nevertheless, the only way of inferring the sufficiency of a new design is by some logical comparison with ships already built and in service. For this purpose, it is sufficient to use the method prepared by Rankin of computing the stress in the hull as a beam loaded with the known weights and buoyed up on the crest of a wave having its own length, or supported across two crests at the ends of the ship. The customary assumption of a trochoidal wave should always be made, firstly because it *is* customary, and secondly because it is at least as good as any other. It must be distinctly understood that the apparent stress determined by this method is a conventional figure which has little direct relation to the real stress in a ship at sea. The stress so determined for a large steel ship is liable to look excessive, though the ship is undoubtedly able; for a small ship the stress looks small, but no one proposes to reduce the scantlings for that reason. When the computed stress varies much from customary figures, then the designer considers whether the design should be modified. Having this in view, the "Smith" correction for the dynamic pressure of the wave is a curiosity that should be included in the course for students in colleges so that they may not overlook it, especially as the correction is of the order of five percent, which no man can interpret into an opinion regarding the safety of the hull of a ship.

The eighth and last chapter of the book gives a brief résumé of the problem of powering a ship, perhaps because the propeller and the engine to drive it are claimed by the marine engineer. In a book of this size sunch a résumé is perhaps all that can be given, but since the naval architect is expected to give the required power as the basis of the engine design this brevity must be regretted.

To sum up this text-book is recommended to all students of naval architecture. It is well adapted to the needs of those who have not the advantages of a full college course and students in such a college will find its treatment clear and direct and will welcome its practical atmosphere.

Two Books on Boiler Construction

REVIEWED BY H. H. BROWN*

The Theoretical and Practical Boiler Maker and Engineers' Reference Book. By Samuel Nicholls. Size, 4¾ by 7¼ inches. Pages, 273. Numerous illustrations. New York, 1912: J. S. Ogilvie Publishing Company. Price, $2.50.

It would seem a somewhat difficult task to compile a book which would be equally useful for the practical workman in the boiler shop and the engineer who has to design the work. This book, however, covers such a wide range of topics essential to a thorough understanding of the work of boiler making, that it will be found a useful aid in the drawing office of the engineer as well as in the hands of a layer-out or foreman boiler maker who directs the actual construction work. The aim of the author, as expressed in the preface, has been to express everything as clearly as possible, so that no formulæ will be encountered which cannot be easily mastered by anyone possessing a fair knowledge of arithmetic. The book begins with a table, giving the diameters, circumferences and areas of circles, information which is indispensable in boiler work. Tables are also given of the dimensions for internal and external angle iron and tee bar hoops, with rules for ascertaining the required length of a straight bar for the formation of any hoop which is likely to be used in boiler work. These are followed by tables of weights of different materials and shapes commonly used in boiler making. The subject of the strength of boilers is taken up in detail, and the methods of calculating various parts are explained by examples. A very complete chapter is given on riveting, which is accompanied by tables giving the pitch and diameter of rivets for different thicknesses of plate. An important chapter is that discussing the repairs of steam boilers. Welding, construction, setting, boiler power, incrustation and calculation of the ordinary lever safety valve are also discussed in detail. The last chapter in the book is upon templet work, and this the author considers as of more importance than any other given in the volume. We quite agree with the author as to the importance of templet work in boiler making; but we think that it deserves a more extended treatment than is accorded it in this chapter. The simple problems explained present no insurmountable obstacles to the beginner, but the actual application to sheet metal work requires further study than is outlined in this volume.

Perkins' Tables. By Lyman B. Perkins. Size, 5 by 7½ inches. Pages, 361. Hartford, Conn., 1912: Lyman B. Perkins. Price, $5.00.

This book contains a large number of convenient tables for use in the calculations for safe working pressures on boilers, compiled by a man who is a past assistant engineer of the United States navy, and who has been employed in various capacities for 25 years by one of the large boiler inspection and insurance companies, and at the present time is holding a certificate of competency as an inspector of steam boilers in the Commonwealth of Massachusetts. Evidently the author has found, and apparently appreciates the fact, that any one else who has regularly or occasionally the duty of calculating the safe working pressures to be allowed on boilers also finds that this work is not only tedious but objectionable as a source of possible errors and waste of time in checking up and correcting the original work. Realizing this, he has set to work and compiled the actual values, calculated absolutely in

* Editor of *The Boiler Maker*, New York.

accordance with simple rules governing particular cases, of the safe working pressure to be allowed on boilers. The results obtained and tabulated in the book were derived by the use of whole numbers and decimals, if any existed, to such an extent that the tabulated results are practically absolutely free from error. Where particular laws or rules governed calculations such laws and rules are absolutely adhered to. Those familiar with the usual procedure for obtaining the safe working pressure of the boiler know that it requires at least four operations of multiplication and division after certain values entering into the computation have been calculated by numerous other computations. The tables published in this book cover these operations to the extent that only a single multiplication and a simple division are required to obtain the result.

The first tables in the book give the bursting pressures of thin hollow cylinders without a joint. Next comes the subject of head bracing, with complete tables for the ordinary sizes of heads commonly used. Following this are tables of segmental areas. Then, practically the rest of the book, or about three hundred pages, is given up to tables showing the strength of riveted joints. These tables include lap and butt joints calculated for sixteenth-inch variations in pitches for lap joints, and for thirty-seconds in variations in close pitches and butt joints; for the different tensile strengths found stamped on the plates, both iron and steel; for the various shearing values of iron and steel rivets approved by use or special law; for thicknesses of material varying by thirty-seconds inch from one-quarter inch up to fifteen-sixteenth inch. A complete table of pitch joint efficiencies is tabulated, which is calculated in strict compliance with the law as given in the rules of Board of Boiler Rules of the Commonwealth of Massachusetts recognizing the specific value given to the shearing of steel rivets, the crushing value of steel plates, and also the least thickness of butt straps estimated with each thickness of plate. In addition to these tables on joint efficiencies two separate tables are given which may properly be termed keys to efficiency calculations, as they are provided to reduce to a minimum the labor of calculating the efficiency of a pitch joint. The methods of calculating these efficiencies are fully explained on pages immediately preceding the tables. This book is most assuredly a valuable aid to boiler makers.

COAL. By E. E. Somermeier. Size, 6 by 9 inches. Pages, 175. Illustrations, 8. New York, 1912: McGraw-Hill Book Company. Price, $2.00 net.

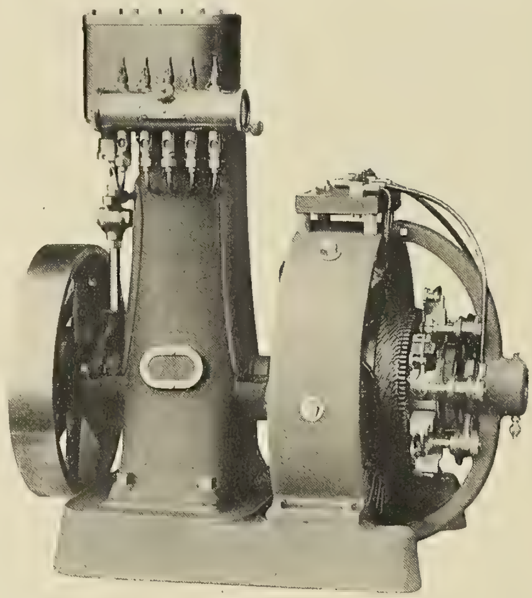
This book treats of the composition, analysis, utilization and valuation of coal. The data and descriptive matter given are largely based upon private notes and upon information scattered through books and the various publications in the engineering press. It is the intention of the author to present this data in such a form as to be readily applied and interpreted, and readily utilized by those who have an active interest in coal, which means practically everyone who is concerned with the generation of power. Three distinct classes of readers have been kept in mind in arranging the book, namely, the mechanical and power plant engineer, the chemical engineer and chemist, and the non-technically-trained business man and operator who has to do with the buying and selling of coal.

In attempting to present data which might be of interest and value to these different groups of readers a portion of the book will necessarily seem elementary to some and a portion will seem correspondingly technical to others. Good advice to each reader is to select that which may be of interest and value, and to pass over any other discussion or data which may appear too elementary or too technical for his needs. At all events the author has succeeded admirably in presenting his subject so as to meet the needs of such different classes of readers.

ENGINEERING SPECIALTIES

Electric Lighting of Dredges

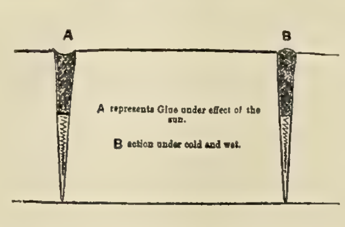
Recognizing the absolute need and convenience of electric lighting for dredging and excavating operations, the Bucyrus Company, Milwaukee, Wis., a prominent dredge building concern, has placed on the market a standard electric lighting set designed to meet these particular conditions. The set comprises a generator and engine mounted on a sub-base with brackets for mounting a rheostat and switches. The necessary wiring, lamps, cleats and other accessories are included with the set. The engine is of the vertical reciprocating type,



directly coupled to the generator, which is mounted on the same sub-base with the engine, a construction which it is claimed entirely eliminates the possibility of its working out of line besides making it a more compact unit. Both machines are of strong, rigid construction and highly efficient under operation. The generator is of a multi-polar direct-current type with radial brushes. The leads terminate at a board mounted upon insulators on top of the dynamo frame. The engine is equipped with sight feed lubricators and an automatic governor.

Marine Glue for Paying Deck Seams

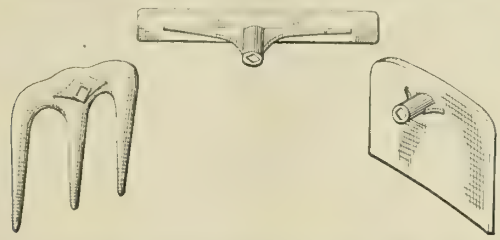
One of the most valuable qualities of marine glue for paying deck seams is its flexibility, as it allows the deck planking to contract and expand while still retaining its great adhesive power to the edges of the planks. The illustration shows how this effect takes place. It is claimed that 14 pounds of Jeffrey's



extra quality marine yacht glue will run from 200 to 250 feet of seam ¾ inch deep by ¼ inch wide. If properly used and not overheated it is said to last from four to six years in a seam, and has been known to last ten or twelve years. L. W. Ferdinand & Company, Boston, Mass., handle this glue.

Indestructo Fire Tools

It is a common complaint from the boiler room that the ordinary fire tools are unsatisfactory, in so far as their durability and wearing quality is concerned. In order to overcome this difficulty the Indestructo Fire Tool Company, Philadelphia, Pa., has brought out a set of fire tools of standard pattern but made of a new composition metal especially de-



signed to withstand the hard use to which such tools are subjected under particularly high temperature. Practically no change is made in the shape of the tools except that they are strengthened at the points most subject to wear, but the chief advantage claimed for them lies in the composition of the metal, which is a special high heat-resisting alloy capable of withstanding the hard usage to which such tools are put.

Prevention of Minor Accidents on Vessels

"It is cheaper to prevent accidents than to have them." A new force has been given this phrase by the activities of the American Museum of Safety, whose director, Dr. William H. Tolman, has made a thorough study of causes, costs and prevention of industrial accidents in this country and abroad. This matter is now generally well understood, and the question of prevention of accidents in minor forms is receiving careful attention. On board ship, however, the safety of employees and passengers has received less attention than should be given to a matter of such importance. While it is true that the *Titanic* disaster caused a very active interest in the question of life-saving when steamships are disabled or sinking, little has been done to make life and limb safer in ordinary day-in and day-out circumstances. For instance, in the engine and boiler rooms the possibility of slipping on the metal stair and ladder treads and floor plates, where oil is always present, is a very real danger. A metal has been produced, however, by the American Abrasive Metals Company, of New York, called "feralun," which has alundun grit cast in the surface, and which it is claimed is a practical preventative of slipping under all conditions, even when covered with oil. The safety ensured by the use of this metal in the stairs, ladders and platforms in the engine and boiler rooms of a vessel is evident, and its use could undoubtedly be extended with advantage to the passenger accommodations for similar purposes.

Make-Up of Technical Journals.—The publisher of International Marine Engineering appreciates very highly the compliment paid him by the publishers of *The American Machinist, Power, The Electrical World* and several other technical journals which began the year 1913 by adopting the general make-up of this magazine. When the size of International Marine Engineering was increased from 8 by 11 to 9 by 12 in January, 1905, we succumbed to commercial conditions and put advertising on the front cover in place of the Table of Contents. In order not to ignore the rights of subscribers we placed the Table of Contents on the first page of white paper immediately inside the cover. On the recommendation of a well-known eye specialist we adopted two columns to a page as far better for the eyes than three columns. This same rule applied to the advertising pages. Furthermore, we put the Buyers' Directory in the back part of the advertising pages and had it followed immediately by the Alphabetical Index to Advertisers, a general plan of make-up which, after waiting seven years, other publishers have wisely adopted.

SELECTED MARINE PATENTS

The publication in this column of a patent specification does not necessarily imply editorial commendation.

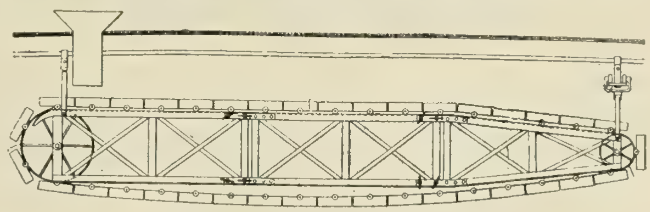
American patents compiled by Delbert H. Decker, Esq., registered patent attorney, Loan & Trust Building, Washington, D. C.

1,035,291. SUBMARINE SOUND-SIGNALING APPARATUS. EDWARD C. WOOD, OF SOMERVILLE, MASS., ASSIGNOR TO SUBMARINE SIGNAL COMPANY, OF WATERVILLE, MAINE, A CORPORATION OF MAINE.

Claim 1.—An apparatus comprising a motor having a pressure chamber, an exhaust chamber, a fluid pressure operated controlling valve, an escape pipe, leading from said exhaust chamber, and also communicating with said valve, and means permitting the passage of fluid pressure through said pipe to said valve without entering said exhaust chamber, whereby said escape pipe serves also as means for transmitting fluid pressure impulses to said valve. Four claims.

1,038,588. APPARATUS FOR COALING SHIPS. MICHAEL S. IVERSON, OF NEW YORK, N. Y.

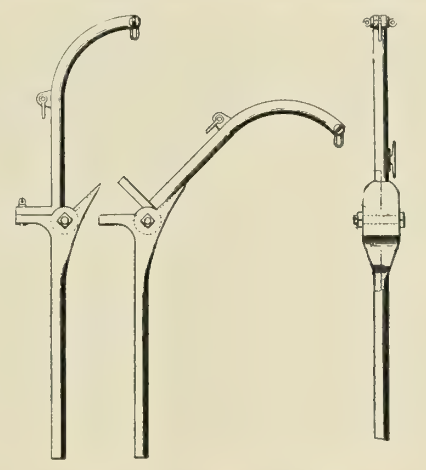
Claim 1.—In an apparatus for coaling ships, the combination of a conveyer, means for pivotally suspending the same at one end below a ship's deck to permit the conveyor to swing horizontally thereunder, an



arc-shaped track suspended from the deck at the other end of the conveyer and concentric with the pivotal support of the conveyer, a carriage running on said track and supporting the adjacent end of the conveyer, and means permitting adjustment of said track above the conveyer. Five claims.

1,040,822. BOAT DAVIT. CHARLES E. WATERWORTH, OF LAS CASCADES, CANAL ZONE.

Claim.—A boat davit comprising a vertical member having a pair of parallel ears and a socket intermediate the same, a curved upper member having an ear arranged in the socket, a pivoting bolt passing through said ears to pivotally connect said members, an angular supporting bearing carried by the first member and adapted to support the curved member at an obtuse angle to the first member, laterally extend-



ing supporting feet on said members adapted to abut each other when the members are in alinement, a locking pin passing through said feet and adapted to hold the feet together, a rope cleat carried by the curved member, and a lifting clevis carried by said curved member. One claim.

1,036,082. AUTOMOBILE TORPEDO. GREGORY CALDWELL DAVISON, OF QUINCY, MASS., ASSIGNOR TO ELECTRIC BOAT COMPANY, OF NEW YORK, N. Y., A CORPORATION OF NEW JERSEY.

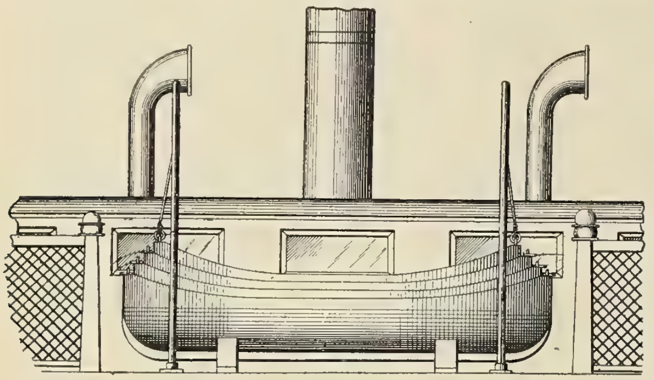
Claim 2.—In an apparatus for generating motive fluid for automobile torpedoes, a casing forming a combustion chamber and having means for supplying a combustible and an oxygen-carrier to said chamber in combination with a carrier supporting an ignition fuse having a percussion cap, a spring-actuated striker for said cap, a latch for restraining the striker, and mechanism actuated by pressure in the combustion chamber to release the latch and allow the striker to strike the percussion cap. Six claims.

1,042,892. RELEASABLE-FLUKE ANCHOR. GEORGE E. CHAMPLIN, OF PAWTUCKET, R. I.

Claim 1.—A folding anchor comprising a shank having an enlarged head at one end thereof, the inner surface of said head being provided with a plurality of lugs, a plate detachably secured to said lugs, said head and plate being provided with alined elongated slots, flukes pivotally mounted between said head and plate on opposite sides of said slots, and a locking block slidably mounted in said slots and adapted to engage said flukes for retaining the same in extended position. Four claims.

1,040,340. LIFE-BOAT. CHARLES JENKINS AND AMANDA A. JENKINS, OF PHILADELPHIA, PA.

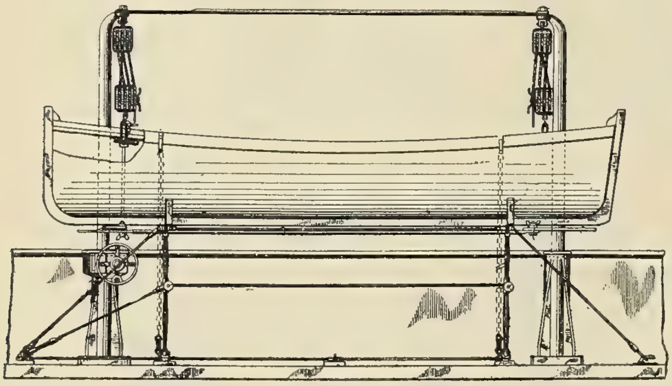
Claim 2.—The combination of a plurality of nested boats, each boat comprising a shell formed from a single sheet of metal, a keel integral with the boat, a portion of said keel V-shaped to receive the keel of another boat, the remaining portion of the keel formed of two thicknesses



of metal bent back upon each other, longitudinal brace bars at the inner edge of each boat, and angle iron bars secured to the inner face of the sides and bottom of each boat, each boat fitting into the next larger boat below, and supported on the bars therein, for the accommodation of seats and oars. Two claims.

1,040,741. APPARATUS FOR STOWING AND LAUNCHING SHIPS' BOATS. AREND R. NYBOER, OF EDAM, NETHERLANDS, ASSIGNOR TO GEORGE H. DIEHL, JR., OF NEW YORK, N. Y.

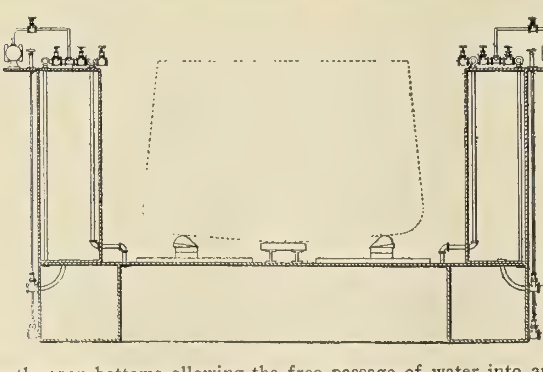
Claim 1.—A collapsible support for a ship's boat, comprising a frame hinged at its foot and hinged between its upper and lower ends, a chock at the upper end of the frame, a connection from the deck to the



frame at its upper end to hold the upper end in position and a connection from the deck to the frame between its ends to prevent the frame from collapsing. Twenty-five claims.

1,043,411. FLOATING DRY-DOCK. GUNNAR C. ENGSTRAND, OF TOMPKINSVILLE, N. Y.

Claim 1.—In a floating dry-dock, wings, a body, on which said wings are mounted, having fluid chambers provided with closed bottoms and supporting the dock when raised and fluid chambers provided with per-



manently open bottoms allowing the free passage of water into and from said chambers and means adapting air to be supplied to the open bottom chambers, to force water therefrom, to the supporting chambers in the body and adapting air to pass back and forth between the open bottom chambers and the supporting chambers in the body. Eight claims.

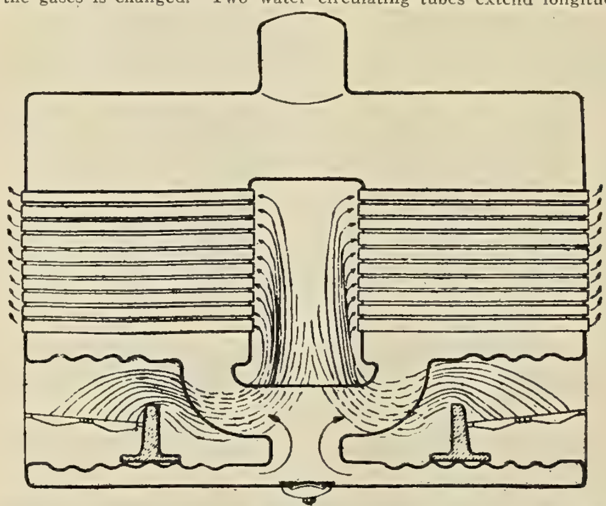
British patents compiled by G. F. Redfern & Company, chartered patent agents and engineers, 15 South street, Finsbury, E. C., and 10 Grays Inn Place, W. C., London.

22,218. MECHANISM FOR CLOSING AND LOCKING PORT HOLES AND OTHER DEVICES. W. V. GILBERT, OF 58 KENSINGTON HALL GARDENS, LONDON.

This invention relates to means for closing and locking portholes, etc., and consists in providing on a carrier stationary guide ribs with which the pin upon the locking member or ring engage, for the purpose of ensuring that the latter, which is turnably mounted upon the carrier, remains in a fixed position in relation to the carrier while it is being turned about its hinge by means of a handle, lever and link which, at the desired moment, rotate the locking member so that projections engage under the flanges, the pin meanwhile moving out of the guides through a gap.

10,465. IMPROVEMENTS IN MARINE BOILERS. E. KING, ZURICH, SWITZERLAND.

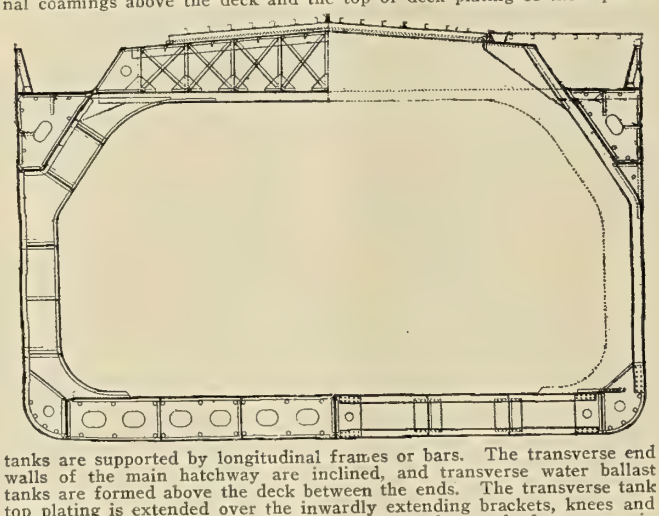
This invention relates to an improved marine boiler, comprising a shell, flame tubes, groups of fire tubes at the left and right-hand sides of the boiler, and a common combustion chamber in which the direction of the gases is changed. Two water circulating tubes extend longitudi-



nally of the furnace tube towards the fire doors of the respective halves of the boiler, from the upper part of the flame tube, and pass underneath the chamber. The tubes communicate with a single tube that extends through the lower part of the flame tube at a part about midway of its length.

25,595. IMPROVEMENTS IN SHIP CONSTRUCTION. SIR W. G. ARMSTRONG, WHITWORTH & CO., LTD., OF NEWCASTLE-ON-TYNE, AND N. H. NURGESS, OF STOCKSFIELD-ON-TYNE.

This invention relates to the construction of a ship for carrying bulk cargo of the kind having the walls of its hold space inwardly inclined from about the water line to the level of the main hatchways and having water ballast tanks below the weather deck and outside the inclined portions of the walls, wherein the outer side or shell plating, the longitudinal coamings above the deck and the top or deck plating of the top side



tanks are supported by longitudinal frames or bars. The transverse end walls of the main hatchway are inclined, and transverse water ballast tanks are formed above the deck between the ends. The transverse tank top plating is extended over the inwardly extending brackets, knees and longitudinal beams to form a narrow deck or fore and aft gangway in way of the hatchways. Around the margins of the hatchways channel section bars are secured and the flanged lids or covers hinged to the sides of the hatchways when turned back, rest on the bulwarks so as to form discharging platforms.

14,775. TARPAULINS ON SHIPS' HATCHWAYS, ETC. J. VON RIEGEN, BREMERHAVEN, GERMANY.

For fixing tarpaulins over hatchways, a spring clamp adapted to be rotatably held in a fixed socket is provided. In order to maintain the clamp in position the rear end of its stem is provided with a projection bearing against a shoulder in the socket, but to allow of its withdrawal there is formed in the socket a groove through which the projection can pass.

International Marine Engineering

Published Monthly by ALDRICH PUBLISHING CO.

17 BATTERY PLACE, NEW YORK — 13 CHRISTOPHER ST., LONDON, E. C.

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Vol. XVIII — MARCH, 1913 — No. 3

Recent Warships for the French Admiralty

Two noteworthy launches took place in France during the latter part of 1912. On September 28 the battleship *Paris* was launched from the yards of the Forges et Chantiers de la Mediterranée, La Seyne near Toulon, and on Nov. 7 the battleship *France* was launched from the yards of the Ateliers et Chantiers de la Loire, St. Nazaire. The *Paris* and *France* are sister ships, both of which were laid down in August, 1911, and are to be completed in 1914. Their principal dimensions are:

Length between perpendiculars	541 feet 4 inches.
Breadth	88 feet 7 inches.
Maximum draft	29 feet 7 inches.
Displacement at full load	23,457 tons.
Brake horsepower	28,000
Designed speed	20 knots.

They are to be driven by Parsons turbines actuating four propellers. The normal supply of coal will be 900 tons and the maximum 2,700 tons. There will also be provided 1,000 tons of fuel oil, giving the vessels a steaming radius of 8,400 miles at 10 knots and 2,300 miles at 20 knots. The armament consists of twelve 12-inch guns placed in six turrets, two forward and two aft and one on either broadside amidships. The secondary armament consists of twenty-two 5.5-inch quick-firing guns. There are four 18-inch submerged torpedo tubes. The vessels are well armored, the main belt amidships having a maximum thickness of 11 inches, which is reduced to a minimum of 7 inches at the bow and stern. The turrets and conning tower are protected by 12-inch armor.

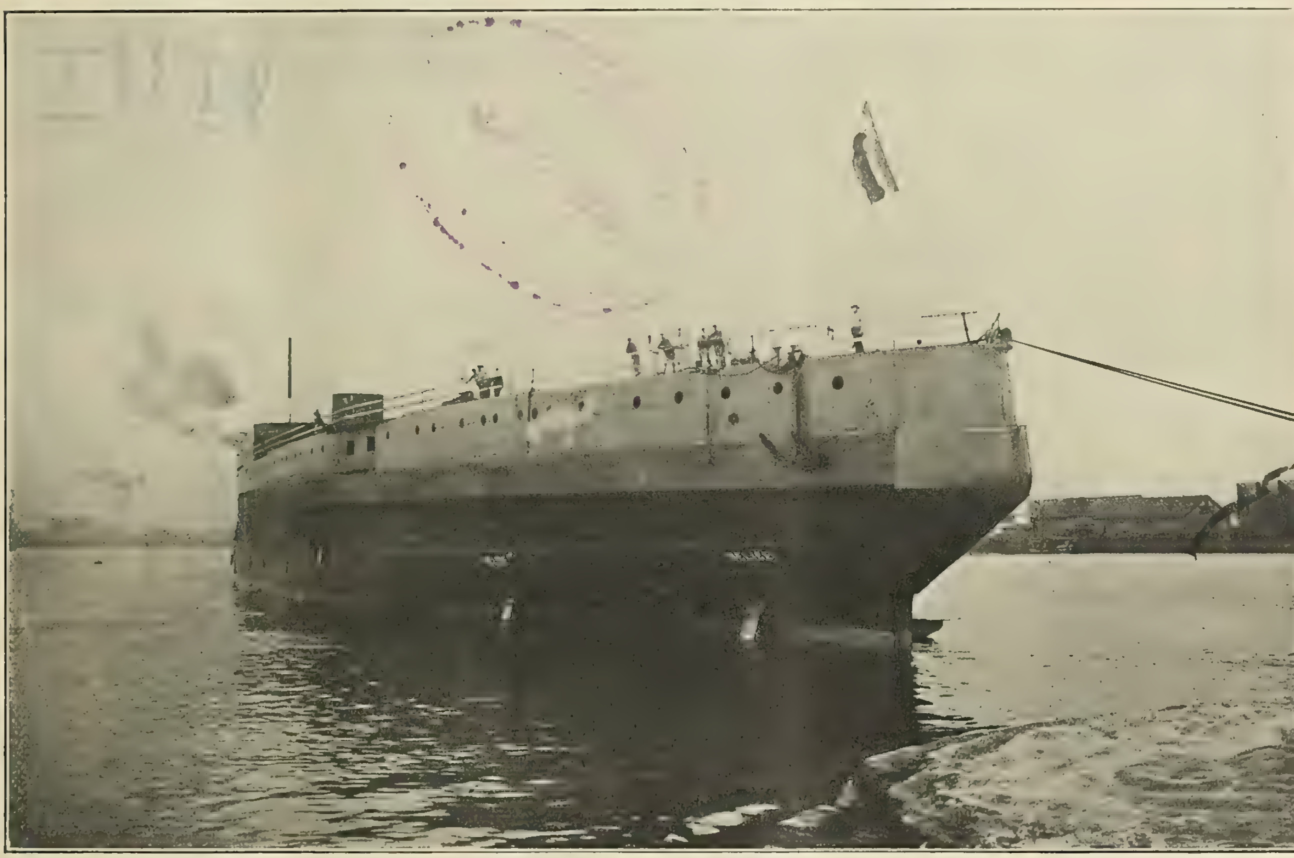


FIG. 1.—STERN VIEW OF THE BATTLESHIP FRANCE

Both launches were of particular interest because they were carried out by entirely different methods—the *Paris* was launched according to English practice and the *France* according to the custom of the yards in which she was built. The former, or English method, is recognized as being the safer, but also the more costly. The second method is much quicker and less expensive, but is more hazardous.

At the Mediterranean works the vessel is always carried in a cradle resting on two sliding ways, and therefore has great stability during the launching, together with a minimum possibility of accident. The sliding ways built for the *Paris* had a total length of 423 feet and a breadth of 6 feet 7 inches, the declivity being 75 in 1,000. The total weight of both the ship and the cradle in this case was nearly 8,000 tons. Each forward poppet was strongly built of wood securely fastened outside the hull plating by round bar stays worked below the keel and fastened to the sliding ways on each side. The lower part of the poppets was designed as a curved bearing surface having a large radius. The cradle also at its upper part had a corresponding curved surface, so that when the stern of the ship became water-borne the forward part of the ship was pivoted by means of the curved surfaces between the cradle and the poppets at the exact point where the maximum stress occurred. The forward poppets had been so constructed as to safely withstand a stress of 1,000 tons per poppet. This method of launching worked perfectly, and the launching was satisfactory in every way.

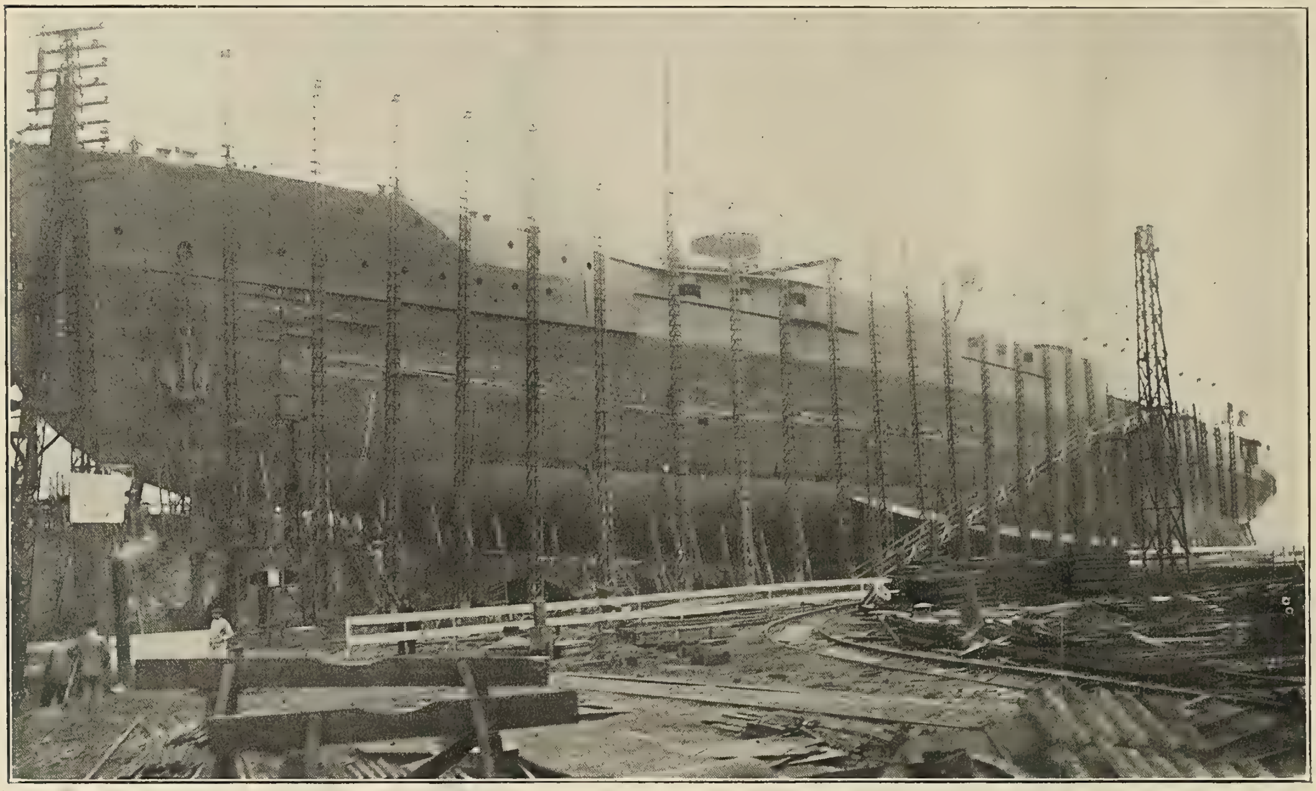


FIG. 2.—BATTLESHIP FRANCE ON THE BUILDING WAYS

The apparatus used to check the vessel on leaving the ways consisted of two sets of chains on each side, the first sets weighing 35 tons each and the second sets 45 tons each. They were connected to the ship by wire hawsers. The first set of chains was to be dragged as soon as the bow of the ship was about 180 feet from the shore, and the second chains were to come into effect after the ship had traveled about 30 feet more. It was expected that the effect of these chains, weighing altogether 160 tons, would stop the ship at about 100 yards from the shore. Owing to the bad weather experienced at the time of the launching, the ship dragged her chains further than the limit expected, and she was finally brought to rest by anchoring about 200 yards from the shore, where she awaited her tugs.

Launch of Battleship France

The *France* was launched in an entirely different way. In this case only a single sliding way was used—that is to say, the entire weight of the ship was sustained at her keel, which was supported on a single sliding way which was 4 feet wide, 10 inches thick and 395 feet long. Of course two additional ways were provided, one under each bilge beneath the docking keels of the ship, which were relied upon as an emergency arrangement in case the ship should become stalled on the ways. No drags of any kind were used to stop the ship, but when she was about 500 yards from the shore her anchors were let go. The weight of the *France* at the time of launching was 7,750 tons. The declivity of the ways was 60 in 1,000, and only 80 seconds were required from the time when she began to move on the ways until she was entirely afloat.

Destroyer Fourche

The destroyer *Fourche* belongs to a group of fourteen 750-ton destroyers ordered in 1910 and 1911 from the dockyards and private yards. The *Fourche* is in every respect a very noteworthy boat, not only on account of her successful trials recently carried out, but because she has been built as a whole strictly according to French design. The boldness with which the lines in the hull have been developed is noteworthy. The hull is an improvement of the *Voltigeur* design described in the July, 1910, number of International Marine Engineering, and is based on the builders' experiments, carried out in the Nantes yard. The turbines for this destroyer have been designed according to Mr. Rateau's arrangement and improved by the Chantiers de Bretagne. The Rateau-Chantiers de Bretagne turbines, together with the Breguet turbines, are the only two turbines of pure French design.

The destroyer has the following particulars:

Length over all	247 feet 11 inches.
Length between perpendiculars	245 feet 11 inches.
Breadth	25 feet 1 inch.
Depth	15 feet 11 inches.
Draft at stern	9 feet 7 inches
Displacement on trials	755.3 tons.

The hull is built of high tensile steel with special longitudinal stiffening. It is divided into ten watertight compartments, stanchions and heavy longitudinal members being worked in all places where the hull and deck are required to sustain extra weights, especially where guns and torpedo tubes are located.

The hull is clincher riveted, the frames being of galvanized steel spaced 2 feet. Bilge keels have been worked on both sides of the hull about one-half the length of the ship. A strong wooden fender has also been worked on both sides of the ship and for about three-quarters of her length. The stem is of forged steel and the stern post and shaft bearings of cast steel. The rudder is of cast steel covered with galvanized plates. The rudder stock is of forged steel. As can be seen from the photographs, the rudder is located under the hull and is, therefore, well protected.

The general arrangement of the *Fourche* is as follows: Forward is the collision compartment; the next two compartments aft of this contain the crew's quarters, while below them are storerooms, fresh water tanks, an ammunition room and chain locker. The fourth and fifth compartments are the boiler rooms, each containing two Du Temple watertube boilers fired with mazout fuel oil, together with the fire-room auxiliaries. The liquid fuel is stored in thwartship tanks and also in the bottom tanks. Fresh water tanks have also been worked on both sides of the hull.

FIG. 3.—DESTROYER FOURCHE ON TRIAL TRIP

The propelling machinery is located in the sixth and seventh compartments. In the sixth compartment is the turbine driving the starboard propeller, together with its condenser and Westinghouse Le Blanc air pumps, etc. There are also two electric generators operated by Sabathé heavy oil motors, an evaporator, bilge pumps, oil pumps for forced lubrication, etc. In the seventh compartment is located the turbine driving the port propeller with its auxiliaries, and also an air compressor, a refrigerating plant, a forced lubricating plant and oil tank.

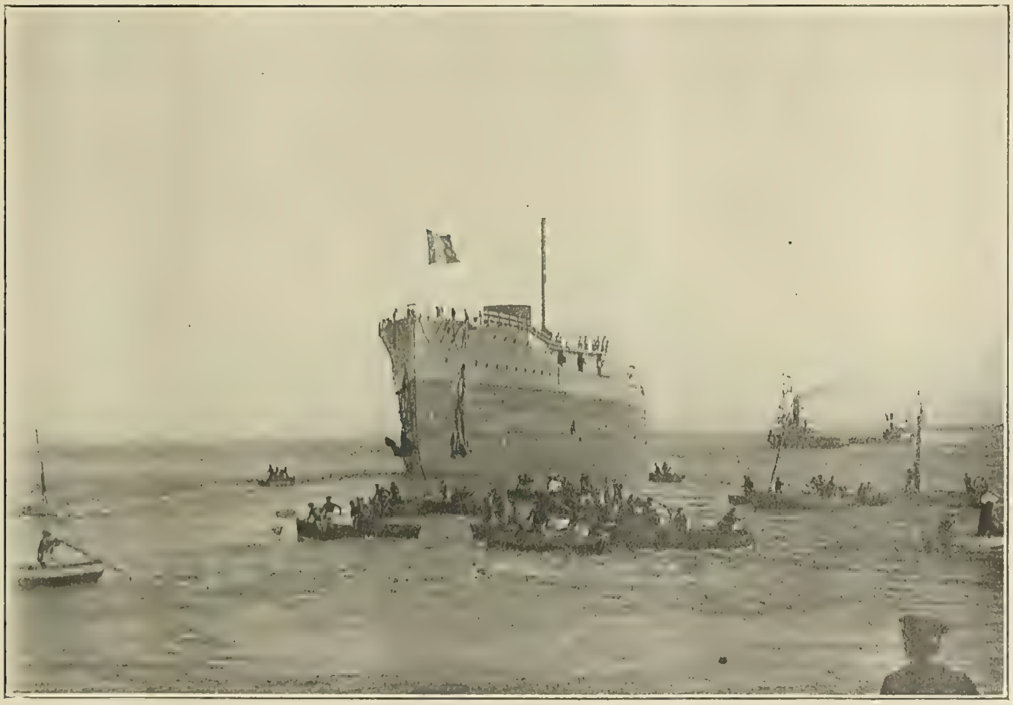


FIG. 4.—LAUNCH OF THE FRANCE

The eighth compartment is devoted to the officers' accommodations, the petty officers are berthed in the ninth compartment, together with the wireless station, while the tenth compartment is a storeroom. Below the eighth and ninth compartments are the ammunition rooms for the guns and torpedo tubes.

The lines of the 750-ton destroyers were designed especially to give better sea-going qualities than previous destroyers for the French navy. The older boats were found to have too

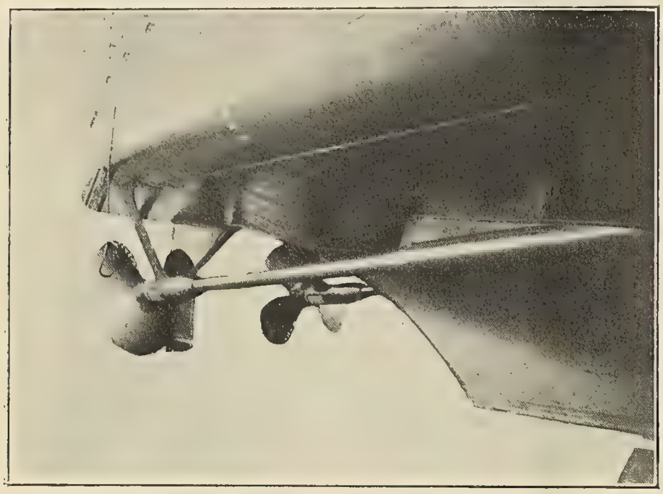


FIG. 5.—STERN OF DESTROYER FOURCHE

little freeboard forward when they met with a rough sea, and under such conditions they were obliged to run at reduced speed in order to avoid heavy damages; for this reason they were unable to make their designed speed except under favorable conditions. The *Fourche*, on the other hand, has a freeboard forward of 14 feet 9 inches and, with the added freeboard and improved design, this type of boat has been found serviceable and capable of good speed in rough weather. The armament of the *Fourche* consists of four 18-inch torpedo tubes located aft; two 4-inch quick-firing guns, one forward on the forecastle and the other aft; and

power the boilers are operated under an air pressure of 7.2 inches of water.

The main engines consist of two marine turbines of the Rateau-Chantiers de Bretagne improved pattern located in two separate engine rooms. These turbines are, therefore, independent of each, and have the advantage that no cruising turbines are required, besides the elimination of complex pip-

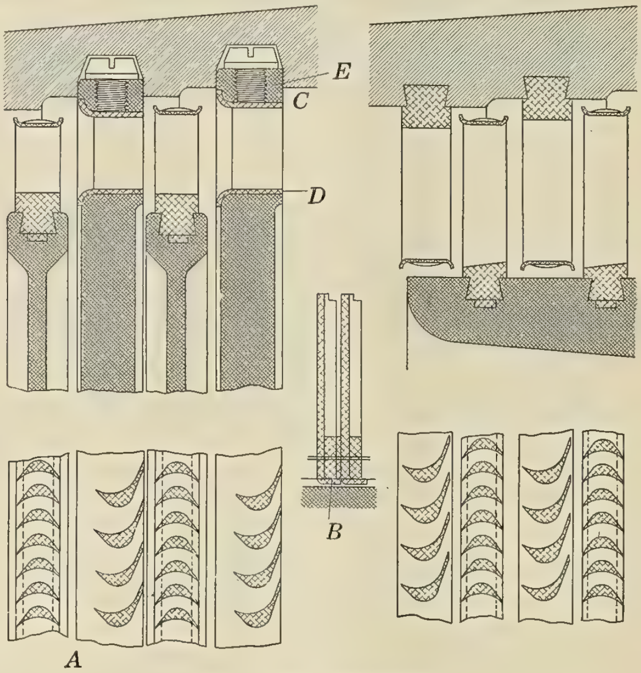


FIG. 7.—DETAILS OF BLADING

ing arrangements. All speeds are obtained by the maneuvering of a single valve.

The Rateau-Chantiers de Bretagne marine turbines are of the impulse multi-cellular type, built so as to obtain on one shaft in one casing all powers required from slow cruising speed up to the maximum speed, as well as reversing, embody-

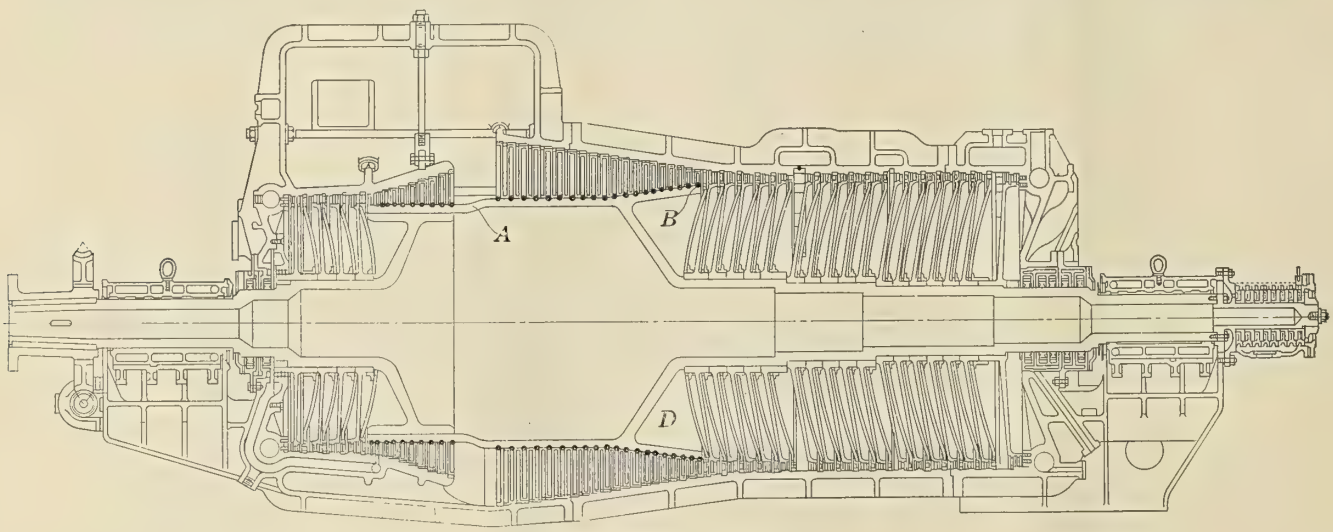


FIG. 6.—SECTION OF TURBINE

four 2.5-inch quick-firing guns located two forward and two aft on each side.

Steam is supplied to the main engines and auxiliaries, as already stated, by four Du Temple watertube boilers fired with mazout fuel oil by Thornycroft burners. These boilers each have a heating surface of 5,167 square feet, the safety valves being set at a pressure of 228 pounds per square inch. At full

ing, in fact, all of the maneuvering qualities of reciprocating engines. On the same shaft and in a single casing are mounted both the ahead and astern turbines, each turbine having blades designed for impulse working and being divided into high-pressure and low-pressure stages. The high-pressure is of large size compared with the low-pressure, and is built according to the multi-cellular system; that is, it is made up of a series of compartments corresponding to pressure stages in which are located wheels carrying several rows of blades, each wheel corresponding to a separate stage and especially calculated with the object of obtaining all required powers in the most economical way. Several valves have been provided in the turbine casing for the delivery of steam into the turbine, each of which represents a predetermined speed of rotation.

The maneuvering of a single hand wheel connected with the special steam valve is sufficient to start the engine or maneuver

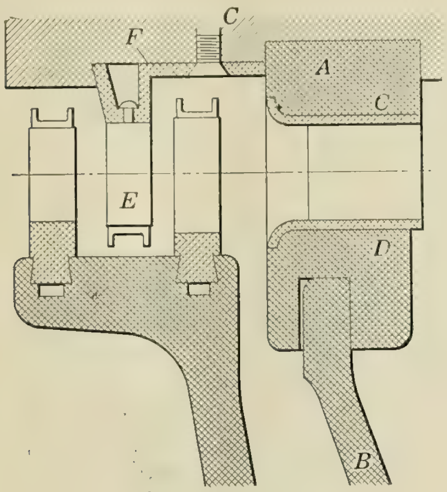


FIG. 8.—BLADING OF WHEEL

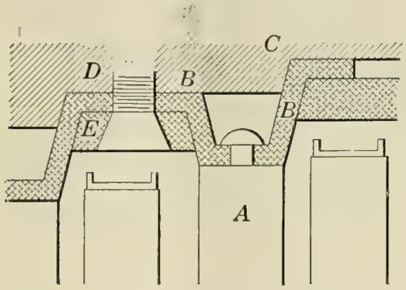


FIG. 9.—BLADING OF DRUM

from one speed to another, or to reverse from ahead to astern. Intermediate speeds are obtained by throttling the steam in order to reduce the pressure.

The low-pressure end of the turbine is built on a drum so as to reduce the weight and counterbalance the thrust of the propeller. The astern turbine is similar to the ahead turbine, but is built to develop only about 40 percent of the ahead power.

The main advantage of the mounting of velocity wheels in the high-pressure part of the turbine is that they answer perfectly to the partial admission of steam. The amount of leakage of steam where the shaft passes through the diaphragms is small and independent of the size of the blades. Moreover, the wheels with diaphragms do not cause any longitudinal thrust on the rotor, while the use of a drum in the high-pressure end of the turbine would require dummy rings or other delicate gear to counterbalance the thrust. The advantages obtained by the use of a drum on the low-pressure stage are that for a similar longitudinal space greater power can be developed by the drum with reaction blading, while the difference of pressure on the two faces of the drum gives a longitudinal thrust which may be regulated so as to counterbalance the thrust of the propeller to any required extent. The propeller thrust in the ahead turbine is counterbalanced by the pressure of steam on the face *B* of the low-pressure drum, while the other face, *C*, of the drum is subjected to the pressure of the condenser. A thrust bearing takes up any inequality in pressure and assures a perfect axial position of the wheels in the cells.

The following data were secured from the trial trips of the destroyers *Fourche* and her sister ship, the *Faux*:

SIX-HOUR FULL SPEED TRIAL

	Fourche.	Faux.
Contract speed	31 knots	31 knots
Contract fuel consumption per hour	$12\frac{1}{2}$ tons	$12\frac{1}{2}$ tons
Trial displacement	725 tons	722 tons
Draft	8 ft. 3 ins.	8 ft. 3 ins.
Steam pressure at boilers	228 pounds	228 pounds
Steam pressure at steam chest	171 pounds	171 pounds
Air pressure in stokehold	7.1 inches	7.1 inches
Fuel oil pressure at burners	185 pounds	192 pounds
Revolutions per minute, average	680	658
Mean speed	33.20 knots	32.01 knots
Maximum speed	33.60	34.90
Brake horsepower, average	18,500	18,500
Vacuum, inches	28.34	28.54
Fuel consumption per hour	10.23 tons	10 tons
Fuel consumption per square foot heating surface	1.12 pounds	1.09 pounds
Fuel consumption per brake horsepower	1.24 pounds	1.21 pounds
Knots per ton of fuel burned	3.19	3.13
Heating surface per B. H. P.	1.12 sq. ft.	1.12 sq. ft.
Surface of condensers per B. H. P.	.33 sq. ft.	.33 sq. ft.
Condition of weather	Smooth sea	Rough sea

EIGHT-HOUR ENDURANCE TRIAL

	Fourche.	Faux.
Contract speed	14 knots	14 knots
Trial displacement	725 tons	722 tons
Draft	8 ft. 3 ins.	8 ft. 3 ins.
Number of boilers under pressure	2	2
Mean pressure at boilers	228 pounds	228 pounds
Mean pressure at steam chest	114 pounds	114 pounds
Air pressure in stokehold	1 inch	1 inch
Fuel oil pressure at burners	114 pounds	114 pounds
Revolutions per minute	242	242
Mean speed	14 knots	14 knots
Vacuum	29.13 inches	29.13 inches
Fuel consumption per hour	2,005.6 pounds	1 ton
Knots per ton of liquid fuel	15.38	15.14

On her preliminary trials the *Faux* ran at an average speed of 33.374 knots, but on her official trials this high speed was not obtained on account of the rough weather and the foul condition of her hull, as the hull had not been scraped and painted for two months. If the full power trials of this vessel had been run under favorable conditions the builders feel confident that she would have attained an average speed of at least 34 knots.

IMPROVEMENTS TO THE WHITE STAR LINER OLYMPIC.—The alterations which have been made to the White Star liner *Olympic* since the foundering of her sister ship, the *Titanic*, involve the introduction of an inner skin extending fore and aft in continuation of the double bottom at the margin plate from the bilge up to a point 5 feet above the 32-foot waterline. The space betwen the inner and outer skin is from 30 to 36 inches. The number of watertight bulkheads has also been increased and some of the bulkheads have been carried to a much greater height in the ship, making the margin of safety of the reconstructed ship far beyond all previously recognized standards. Similar safeguards are also being introduced in the new White Star triple-screw steamer *Britannic*, of 50,000 gross tons, now building at Belfast.

LAUNCH OF THE LORENZO.—The steamship *Lorenzo*, of the New York and Porto Rico Steamship Company, was launched at the yards of her builders, the Newport News Shipbuilding and Dry Dock Company, January 25. This is the fourth vessel built for the New York & Porto Rico Steamship Company by the Newport News Shipbuilding and Dry Dock Company from designs by and under the supervision of Theodore E. Ferris, naval architect, New York. The ship is an exact duplicate of the *Corozal, Montoso* and *Isabela*. The principal dimensions of these ships are: Length, 347.8 feet; beam, 46.7 feet; depth, 25 feet; gross tonnage, 3,063.

A Sample of Old-Time Engineering Skill

BY CHARLES S. LINCH

When one looks over the work of the early naval architects and marine engineers, he is forced to acknowledge with ever-increasing admiration the excellence of their engineering ability and judgment. They had no precedence to follow, and their work stands to-day a monument to their skill from every point of view. A sample of such work can be found in the ferryboat *Long Beach*, which was built in 1880 by the Harlan & Hollingsworth Company, Wilmington, Del., for the East River Ferry Company, New York. Through the courtesy of Mr. H. L. Des Anges, Marine Superintendent Long Island Railroad, the writer is able to present a description and indicator diagrams from the engineers of this most interesting ferryboat.

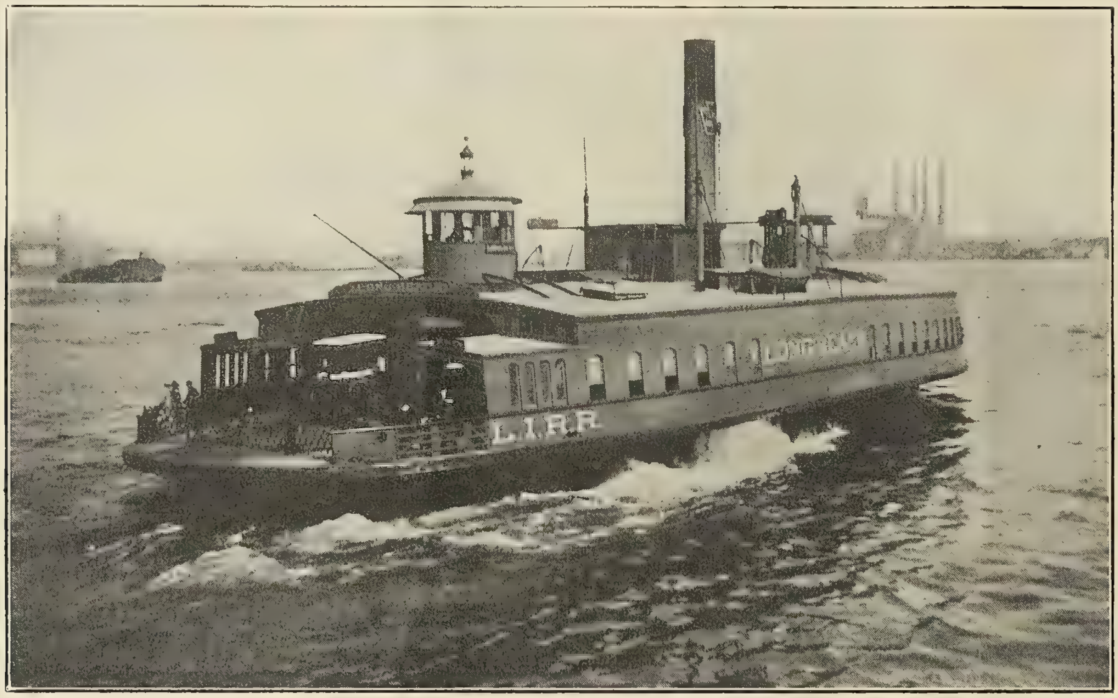


FIG. 1.—FERRYBOAT LONG BEACH LEAVING HER SLIP AT LONG ISLAND CITY

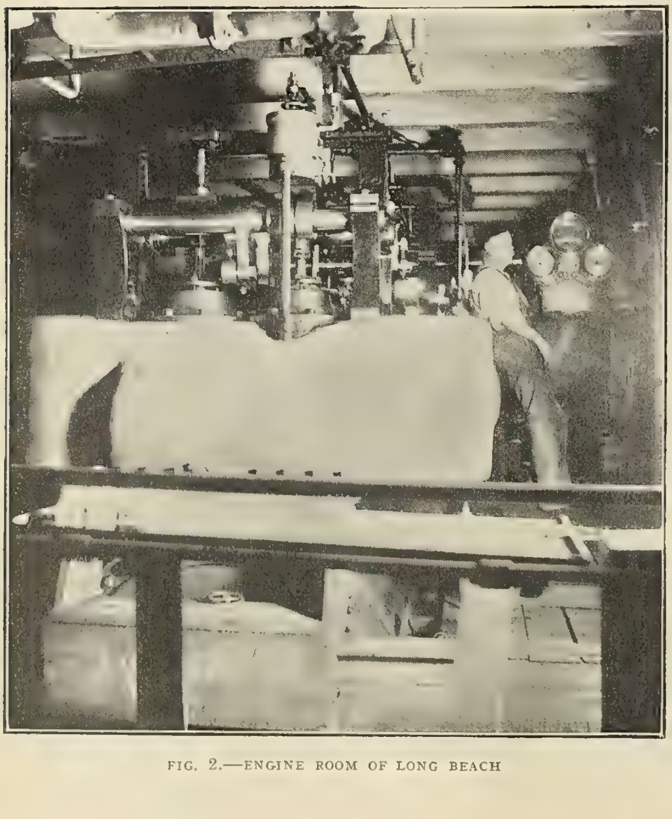


FIG. 2.—ENGINE ROOM OF LONG BEACH

The *Long Beach* is 150 feet long, 32 feet beam, 13 feet 6 inches depth, with a tonnage of 519.51. Steam is supplied by a horizontal cylindrical flue type boiler 28 feet long, 120 inches diameter, operated at a pressure of 40 pounds per square inch. The boiler contains 16 flues made up as follows: Six, 14 inches diameter, 14 feet 6 inches long; six, 14½ inches diameter, 11 feet 10 inches long; two, 23½ inches diameter, 11 feet 10 inches long, and two, 11½ inches diameter, 14 feet 6 inches long. There are two furnaces with a total grate area of 53.66 square feet.

The machinery of this boat is of particular interest. The engine is a single cylinder inclined jet-condensing engine with a cylinder 44 inches diameter and 9 feet stroke. The valves are of the poppet type, having Sickles cut-off gear on the steam valves. The air pump is driven from the engine crosshead through the medium of a vibrating lever, forked to permit the connecting rod to clear. The entire engine seating is built up of plates and angles, forming a part of the ship's structure. The cylinders, guides and main bearings are bolted to a sole plate which rests upon this seating, making a remarkably rigid structure, which is amply proved from the fact that all of the gear now in use is the original gear. The valves are bolted to seatings forming a part of the hull structure. There is one eccentric for ahead gear and one for astern. Fig. 2 is a photograph of the valve gear, showing clearly the dash pot on the steam valve. The engine is handled in the same manner as the beam type. The starting bar is attached to the rock shaft. The lever at the back of the engineer is for the hook control for the ahead or astern gear. The small lever attached to the shaft whose bearings are dependent from deck beams, as can readily be seen, is for controlling the cut-off.

The dimensions of some of the important parts of the machinery are as follows:

Diameter of piston rod	5 3/16 inches.
Diameter of connecting rod, fork end	5⅝ inches.
Diameter of connecting rod, stub end	5⅝ inches.
Diameter of connecting rod, middle	7 7/16 inches.
Length of connecting rod	18 feet.
Diameter of crank pin	7 inches.
Diameter of shaft	13 inches.

The boat is propelled by side paddle wheels 18 feet 10 inches diameter, each wheel having 18 buckets 20 inches wide and 7 feet 2 inches long.

Assisted by the chief engineer of the line, Mr. James Overbaugh, the writer indicated this engine and obtained diagrams of which Figs. 3 and 4 were taken on the 12.48 P. M. and 1.12 P. M. runs, respectively. The scale of spring used in the indicator was 20 pounds.

From Fig. 4 the M. E. P. at the head end was 19.375 pounds and at the crank end 17.5 pounds, making the average M. E. P. 18.4375. The following conditions obtained at the time the diagrams shown in Fig. 4 were taken: The steam pressure at the boiler was 37 pounds per square inch gage and at the steam chest 30 pounds per square inch gage, making a drop between the boiler and steam chest of 7 pounds, and the absolute pressure at the same chest 45 pounds. The initial absolute pressure from the diagram at the crank end is 41.25 and at the head end 38.125, making the average initial pressure from the diagram 35.7 pounds, with a drop between the steam chest and piston of 5.3 pounds. There is, therefore, a loss of 5.3 pounds due to friction in passing through the valves and ports.

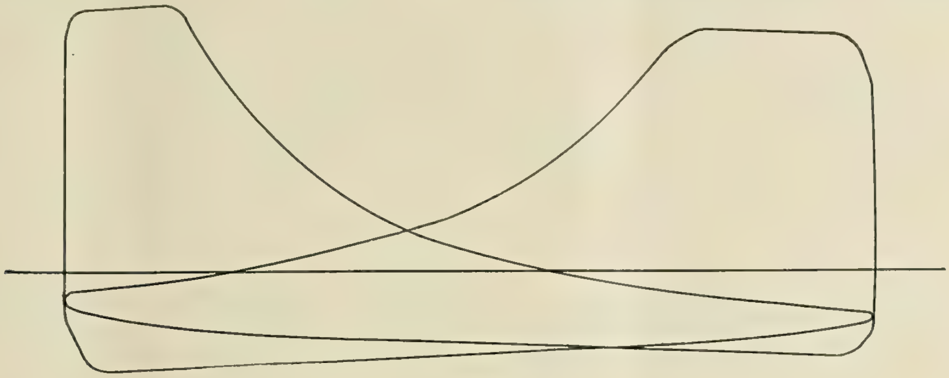


FIG. 3

In Fig. 3 there is a difference of 16.875-15 or 1.875 pounds M. E. P. between the head and crank ends. In Fig. 4 there is a difference of 19.375-17.5, or 1.875 pounds M. E. P., between the head and crank ends. At the time the diagrams Fig. 3 were taken, the engine was working at 22 revolutions per minute, giving a piston speed of 396 feet per minute. The indicated horsepower developed at this time was 578.57.

At the time diagrams Fig. 4 were taken the engine was running at 24 revolutions per minute, giving a piston speed of 432 feet per minute, and an indicated horsepower of 729.

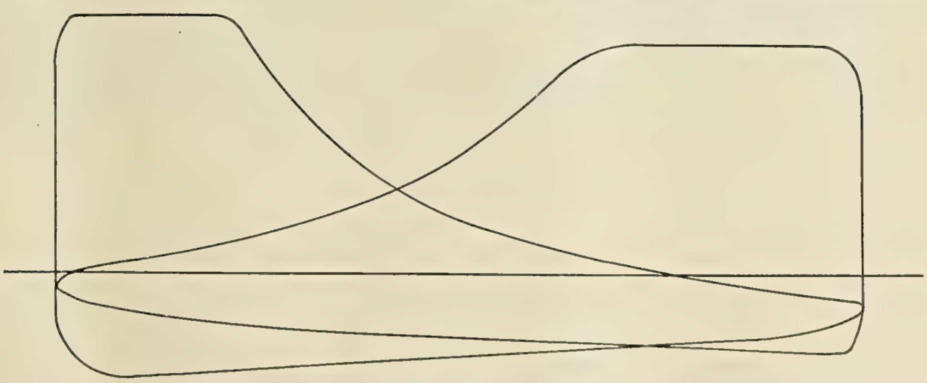


FIG. 4

Referring to Fig. 3 the M. E. P. at the head end was 16.876 pounds and the M. E. P. at the crank end 15 pounds, making an average M. E. P. of 15.93 pounds. The following conditions obtained at the time these diagrams were taken: The steam pressure at the boiler was 35 pounds per square inch gage, the steam pressure at the steam chest 28 pounds per square inch gage, making a drop between the boiler and steam chest of 7 pounds. The absolute pressure at the steam chest was 43 pounds. The initial absolute pressure from the diagram at the crank end is 41.875 and at the head end 40 pounds, making the average initial pressure from the diagrams 41 pounds, with a drop between the steam chest and piston of 2 pounds. The length of the steam pipe is 60 feet, and therefore there is a loss of 2 pounds, due from friction of the steam in passing through the valves and ports.

As these diagrams are reproduced full size, any further analysis desired can be made.

The kind of coal used on this service is low grade buckwheat rice, and the actual cost of fuel for this boat taken from reports is 21.13 cents per mile; labor, 56.24 cents per mile. The crew number six men, including one engineer, one fireman, one captain, two deck hands and one porter.

At the time the foregoing tests were made this boat was in daily operation, running from New York City to Long Island City. The number of hours was twenty-four per day under steam. This boat is thirty-two years old and the steam pressure carried has been cut only 10 pounds in this time. There are no patches on the boiler and the flues and all internal parts are in original condition. Furthermore, the engine cylinder has never been rebored.

The smoothness and ease of running is remarkable, there being no noise or vibration of hull, and unless one hears the bells it is impossible to tell when the engines are reversed. Again, in these engines the workmanship is of a superior grade, which is characteristic of the machinery built years ago and which to-day is conspicuous by its absence. With the old Harlan & Hollingsworth Company it was lose money rather than slight work, which in many instances was done. Not only was this true of this firm, but of the W. & A. Fletcher Company as well, as can be seen by an inspection of their work. The gages used on the boiler and on steam chest were test gages, the indicator was the American-Thompson visible spring type. Both the gages and indicator were manufactured by the American Steam Gauge & Valve Manufacturing Company, Boston, Mass. It is of interest to note further that the original gages and clock fitted when the boat was built were manufactured by the above company.

The turning moment of this engine is remarkably even, as can be proved by plotting same from the pressures taken from the diagrams shown. In certain service there is nothing yet built to equal these engines, or even the jet condenser. Space will not permit an extended analysis, but in the near future the writer will give the readers of this journal an analysis of tests made on compound engines of similar dimensions, one being fitted with surface, the other with jet condensers, and both used in same service, at which time the statement of economy will be proven.

The workmanship on the boiler of this boat is a thing of beauty, and in comparison with that on some of the boilers built within the last four years shows the superior workmanship which obtained thirty-two years ago. Compared on a tonnage basis, or the power required per square foot of wetted surface, there is a greater economy in these engines than in the compound or triple-expansion engine for the same service.

In conclusion, I would call the attention of the reader to the quick action of the valves; note the absence of excessive wire draw, the easy rounded corners and the absence of hump caused by reheating the expanded steam, the straight admission line, or, in other words, the admission line is nearly perpendicular to the atmospheric line. The compression is very small, and while the inertia effects of the reciprocating parts are small, yet with this small compression the engine is running with remarkable smoothness. The head end diagram, of course, shows the steam following a greater percentage of the stroke, and just sufficient to accomplish the result desired. Taken as a whole, it is one of the most interesting engines the writer has had the fortune to analyze, and all credit to those designers that have smoothed the path that we must follow. It would pay us to follow more closely and introduce that engineering judgment which every engineer worthy the name must or should have. The tendency to-day is to install engines of the most modern type for service in which they prove most uneconomical. That is to say, in certain service the compound or triple expansion engines, with their surface condensers and high steam pressures, light construction, etc., are not as satisfactory or economical as the lower steam pressures, jet condensers, with their reduced upkeep.

Since the above was written the *Long Beach* has been sold to the New Jersey and Delaware Ferry Company for service between Wilmington, Del., and Penn's Grove, N. J.

Monthly Shipbuilding Returns.—The Bureau of Navigation reports 79 sailing, steam and unrigged vessels of 24,402 gross tons built in the United States and officially numbered during the month of January. Over 77 percent of this tonnage was built on the Atlantic and Gulf coasts, six of the vessels being steel steamships, aggregating 11,430 gross tons.

A Menhaden Fishing Steamer

BY GEORGE A. DEAN, JR.

One of the most modern and best equipped menhaden fishing steamers hailing from a Virginia port went into commission in July, 1912. This steamer is the *Joseph F. Bellows*, owned and operated by Bellows & Squires, Inc., of Ocran, Va.

The hull and house are constructed of wood and are of the usual design for this class steamer. The lines of the hull are fine, with the primary idea of speed. In keeping, however, to the fine lines, neither the comfort of the crew nor the efficiency of the propelling machinery is sacrificed.

The general dimensions of the hull are: Length, 160 feet; beam, 22 feet 9 inches, and depth, 12 feet. The boat is lighted throughout by electricity and has a powerful searchlight on top of the pilot house. The crew's quarters are located in the forepeak, the engineers' and firemen's quarters are located on the main deck aft of the engine room, and the captain's and mates' quarters are on the upper deck aft of the wheel house. The galley is located on the main deck forward.

Hand-steering gear is used for handling the rudder. The rudder is made up of a steel frame and 10½-pound plates, and then cased in with 2½-inch oak planking, the claim being made that a vessel of this character handles much better and easier with a wood rudder. A galvanized hand brake windlass is located on the forward deck for handling two anchors, which are of 1,000 and 1,200 pounds, respectively. A 6-inch by 6-inch double cylinder friction gear hoisting engine is located in the forward part of the after house for bailing fish and other purposes.

The machinery outfit was built and installed by E. J. Codd Company, Baltimore, Md., and consists entirely of independent units. The boiler was built particularly large to insure free steaming under all conditions. It is of the single end Scotch type, 13½ feet diameter and 12 feet long, containing 296 3-inch charcoal iron tubes 9 feet long, three Morison corrugated furnaces 46 inches diameter, a steam drum 40 inches diameter by 60 inches long, and one common combustion chamber 30 inches wide. The boiler is designed to stand a working pressure of 160 pounds. A double stack 35 feet high, with hood, ruffle and bucket rack, is fitted to the smoke box of the boiler and guyed to eye bolts running from the top of the deck house to the underside of the house sill. All feed and blow valves, which are of extra heavy flanged pattern, are located on top of the boiler shell, in order to give easy access for handling.

The engine is of the two-cylinder inverted fore-and-aft compound type, 16½ inches by 33 inches by 24 inches stroke. It is of very heavy design, which is necessitated by the hard usage to which this class of machinery is subjected. The high-pressure valve is of the piston type, and the low-pressure a double-ported slide valve. The cylinders are separate castings and bolted together at the low-pressure steam chest, the joint being made of sheet copper. The high-pressure valve and the high and low-pressure cylinders are fitted with heavy liners made of the best grade close-grained cast iron. This arrangement precludes the possibility of ever having to make a new cylinder casting on account of wear, and after the liners have been bored and worn out they can be replaced with new ones.

The pistons are of cast iron fitted with snap rings, bull rings and followers. The cylinder heads are of cast iron turned and polished and are fitted with stuffing boxes for taking care of the tail rods.

The engine framing consists of two heavy cast iron columns in the rear and four polished forged steel columns in front. The use of the four columns in front proves a great benefit in decreasing vibration and also admits of better access to the cranks and bearings. The guides are of cast iron, hollowed for water circulation, and are bolted to the cast iron columns. The crosshead slides are cast iron lined with Parsons white brass. The bed plate is of the drop pattern and cast in one piece.

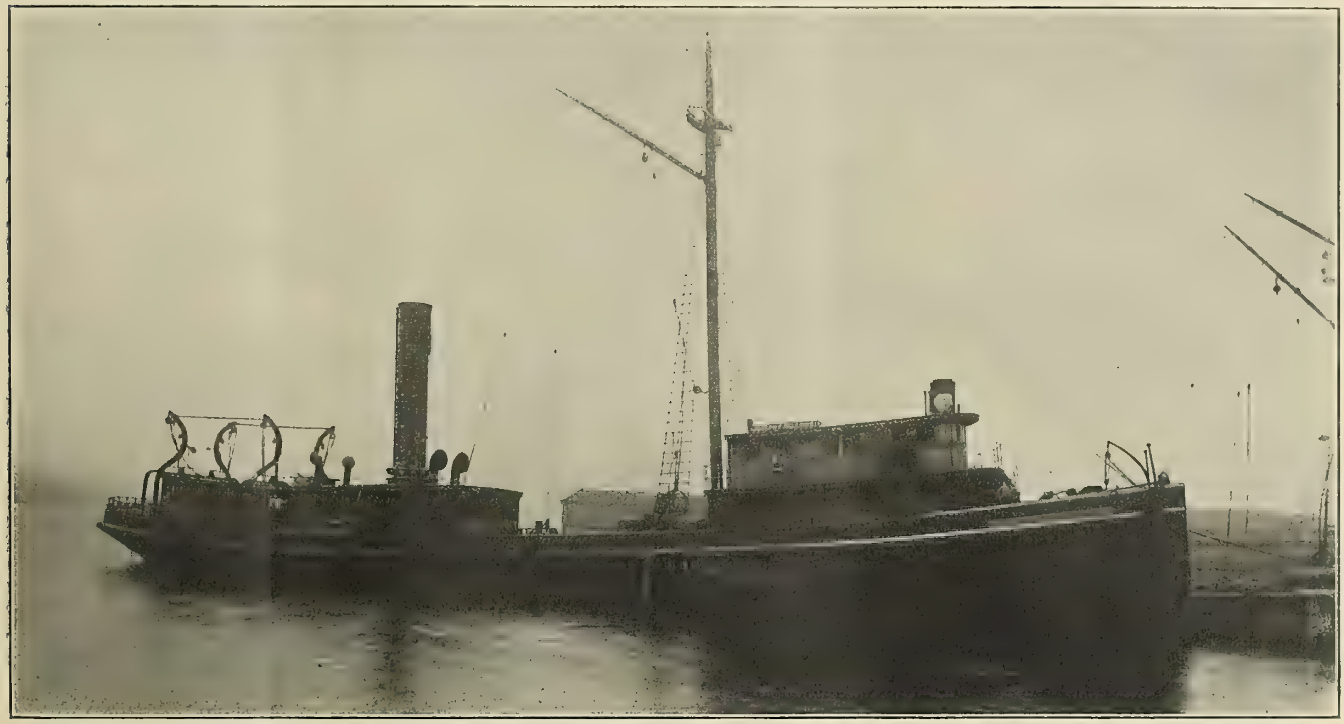
The valve gear is of the Stephenson link motion type, worked by a direct-acting steam reverse engine. Heavy phosphor bronze die blocks are fitted to the double bar links. The piston rods are made of special piston rod steel, and the connecting rods are of hammered iron; all other forgings are of mild steel.

The crank shaft is of the built-up type, 7¾ inches diameter. The pins and shaft are of forged steel, and the slabs, which are counterbalanced, are made of steel castings. The main bearings, four in number, are of ample length to give a good wearing surface; the bottoms of these bearings are of brass, and the tops, which also form the caps, are of cast iron; both top and bottom bearings are filled with Parsons white brass. The eccentrics are of cast iron, as also the straps, which are lined with Parsons white brass. All stuffing boxes about the engine are packed with France metallic packing.

The thrust is of the horseshoe type. The shoes are of cast iron, hollowed for water circulation, and are lined with Parsons white brass. The thrust shaft is an intermediate piece with solid collars turned on same. The tail shaft, which is 9 inches diameter, was made particularly large to take care of corrosion, which always deteriorates the shaft in close proximity to the brass sleeves. The stern bearing and stuffing box are of cast iron and bolted respectively to stern post and shaft log with Muntz metal pocket bolts and brass cap nuts. The propeller is of cast iron, 9 feet diameter by 11½ feet pitch.

The auxiliary outfit consists of one cylindrical shell surface condenser of 1,000 square feet cooling surface, one galvanized iron filter box, one 5-inch centrifugal circulating pump, one vertical beam double cylinder single-acting air pump, one 7-inch by 4½-inch by 8-inch duplex boiler feed pump, and one 7-inch by 4½-inch by 8-inch duplex donkey pump. A departure from general practice is used in connecting the two latter pumps. They are so connected that either one can perform the functions required of either the boiler feed or donkey pump. A 3-inch by 2-inch by 3-inch duplex pump is provided for circulating water through the guides and bearings and thence to the toilet, which is thereby kept constantly flushed. A bath tub is fitted aft for the convenience of the officers. A feed water heater made up of a cast iron shell and internal copper coils was designed and built by the builders of the machinery. All pipe valves and fittings in the connecting up of the main engine, auxiliaries and tanks are entirely of brass and copper, no iron pipe being used for any purpose.

The boiler being fired from forward permitted the building of large 'thwartship and side bunkers, the combined capacity being about 85 tons. The bunkers are constructed of 10½-pound steel plate and, in wake of the boiler, are arranged to be readily taken down. Beside having three bunker deck plates on each side of the house, there are also three forward of the after deck house, the quarter deck being extended to receive them. This prevents trimming and permits of very rapid coaling.



MENHADEN FISHING STEAMER JOSEPH F. BELLOWS

As this class of vessel is likely to be at sea for a number of days, one great essential necessary for the upkeep of the machinery is taken care of in the matter of fresh water. A combined tankage of 14,000 gallons is provided. One tank of 4,000 gallons is placed under the forepeak floor, two tanks of 3,000 gallons each are placed just forward of the forepeak and two tanks of 2,000 gallons each are placed in the stern. These tanks are so connected with the pumps that they can be pumped from forward to aft, or vice versa, and thereby can be used for ballasting or trimming. All of these tanks are provided with a 4-inch filling pipe on each side of the deck house. A hand deck pump is placed on the quarter deck aft, the suction of which is connected both to the bilge and sea and the discharge to the fire mains.

The vessel has completed a very successful season and has exceeded the expectations of both the owners and the builders.

VESSELS CLASSED BY LLOYD'S REGISTER.—Of the vessels launched during 1912, 596 of 1,625,527 tons were built under Lloyd's inspection with a view to classification by this society.

Single Screw Motor Ship of 1,500 B. H. P.

BY J. RENDELL WILSON

There is likely to be a great struggle for supremacy between the makers of the two stroke and four stroke marine Diesel engines. The technical press in general lean towards the two stroke motor as being the future type, but I am inclined to think that the conclusion has been drawn a little too hastily, as one has to consider that two of the prominent makers of four stroke engines in Western Europe have between them on order for ship propulsion alone motors totaling 35,000 brake horsepower, to be installed in vessels aggregating 97,685 tons deadweight capacity. I refer, of course, to Messrs. Burmeister & Wain, of Copenhagen, and the Nederlandsche Fabriek, Werkspoor, of Amsterdam. The former concern has on order a twin screw motor cargo and passenger motor ship of 4,000 indicated horsepower for the East Asiatic Company. This is the highest powered commercial vessel now building. All the numerous big Russian motor craft have four stroke engines, and although these vessels are running on inland waters, much important experience must have been gained. However, it is only fair to state that out of a total of 56 engineering firms no fewer than 40 have adopted the two stroke type Diesel. Despite this I think the four stroke Diesel will hold its own for several years yet, and is likely to prove the most reliable after driving a ship for a number of years. Because of the great number of firms building two stroke engines, this type, however, will be built to a greater extent in time.

It was in May, 1911, that we first described and illustrated a Carels type marine Diesel engine of 1,000 horsepower. Since that time considerable alterations have been made to the design of the Carels motor. Licenses have been granted by the designers to about half a dozen important engineering concerns, including Messrs. Joh. C. Tecklenborg, of Bremerhaven, Germany, who have recently built a general cargo and passenger carrying motor-driven ship of 2,700 tons deadweight capacity for the Hansa Line of Bremen. This vessel is fitted with a six-cylinder Diesel engine of 1,500 brake horsepower mainly built by the firm, the valves and other delicate parts having been constructed in Messrs. Carels works at Ghent, Belgium.

The *Rolandseck*, as she has been named, has now successfully completed her trials, and no doubt will be engaged in trading between Portugal and Germany by the time this appears in print. She is 290 feet long, 275 feet between perpendiculars, with 40 feet beam, and a molded depth of 27½ feet. On a draft of 18 feet 5 inches she will carry 2,700 tons, the holds having 175,000 cubic feet capacity. She is a single screw boat. Therefore her engine is at present the highest powered in service, although the eight-cylinder engines of the *Selandia, Jutlandia* and *Christian X* total 2,500 brake horsepower per boat. But as each cylinder of the *Rolandseck's* engine develops 250 brake horsepower, compared with the 156 brake horsepower of the *Selandia* and her sisters, the advancement is very noteworthy. Her speed is about 10½ knots.

Her engine is of the directly reversible, single-acting class, and each of the cylinders has a bore of 20 inches, by 36¼ inches stroke. They are arranged in pairs, mounted on heavy frames, upon a box bedplate, which is constructed in three sections. Accessibility is, of course, the great advantage of the "open" class of engine, otherwise there are no special features to claim for it, except, perhaps, that it produces a motor greatly resembling the modern marine steam engine. It will be noticed that a railed-off gangway has been arranged between cylinders four and five of this engine, so that the engineers can walk through with perfect safety when the engine is running. The power is developed at 120 revolutions per minute, the indicated horsepower being well over 2,000. The mean effective pressure is about 108 pounds per square inch. Residual oil of 10,000 calories per kilogramme is used as fuel, the consumption being less than .5 pound per brake horsepower per hour, which is not at all bad for a two stroke engine. The most economical four stroke oil engine has a consumption of .43 pound.

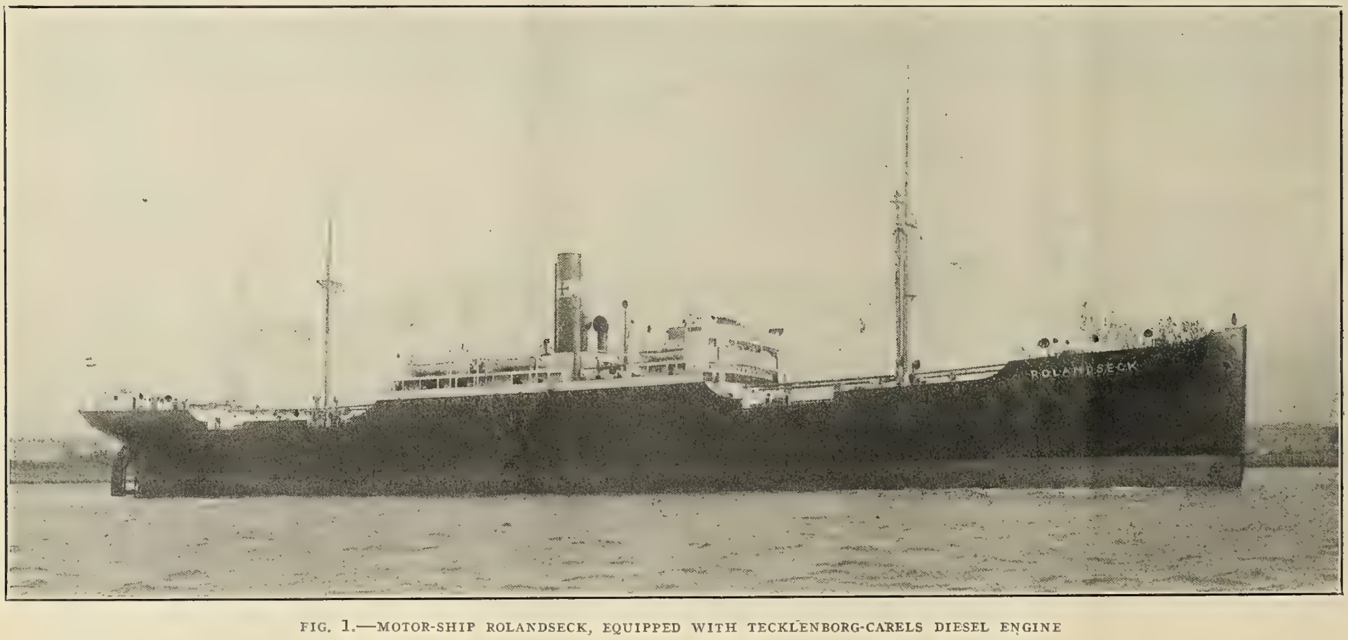


FIG. 1.—MOTOR-SHIP ROLANDSECK, EQUIPPED WITH TECKLENBORG-CARELS DIESEL ENGINE

Compressed air for fuel injection and maneuvering—i. e., starting and reversing—is obtained from a Reavell compressor, which is driven off the crankshaft at the forward end. There are three double-acting scavenging pumps mounted on the port side of the engine and operated by means of rocking levers from the connecting rods of numbers 2, 4, and 5 pis-

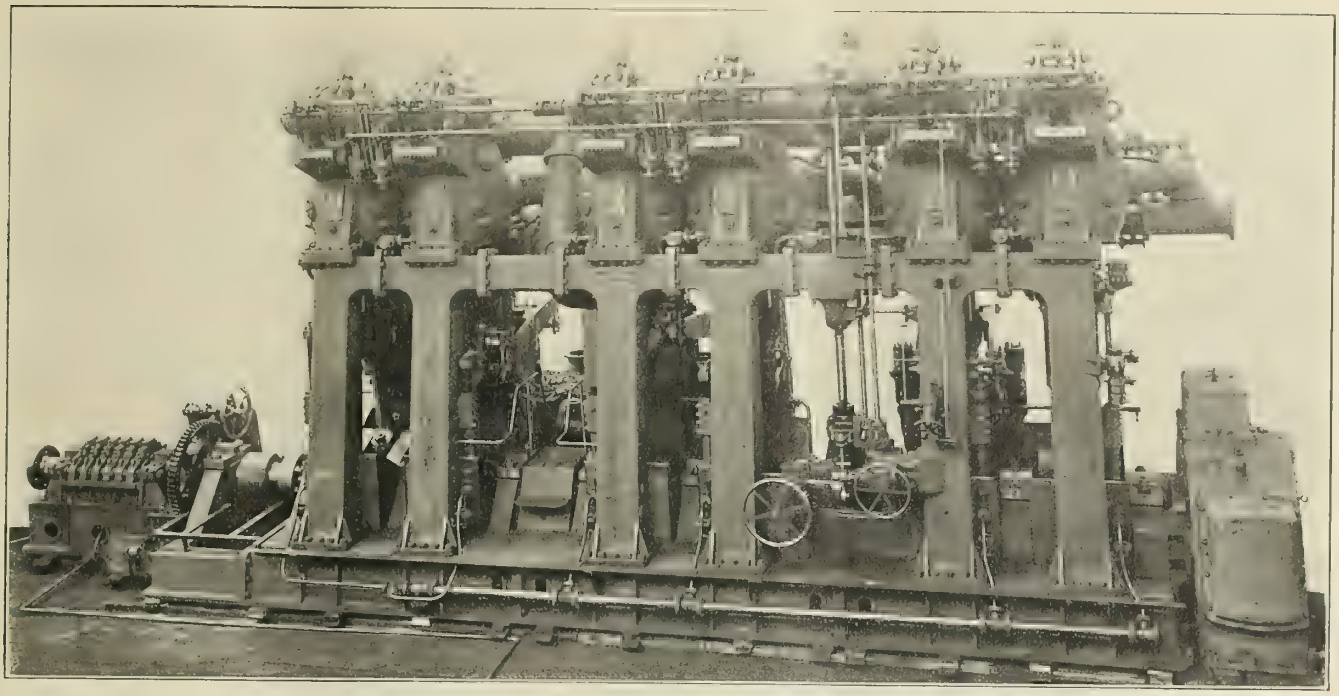


FIG. 2.—SIX-CYLINDER, 1,500-HORSEPOWER TECKLENBORG-CARELS ENGINE

tons. Automatic valves are fitted to the scavenging pumps. The air-starting, fuel-injection, and scavenging valves are all arranged in the cylinder head, and are operated by rockers off a camshaft running horizontally on the starboard side, the camshaft being actuated by a vertical shaft between cylinders 2 and 3.

Altogether there are six valves to each cylinder, but, it will be noticed, only four main rockers. Counting from the forward end of each cylinder, No. 1 rocker works two scavenging valves, which is carried out by the end of this rocker being extended and so operates another rocker. Next come the rockers actuating the fuel injection and starting valves, while No. 4 rocker operates two more scavenging valves in the same manner as No. 1 rocker. Thus it will be seen that there

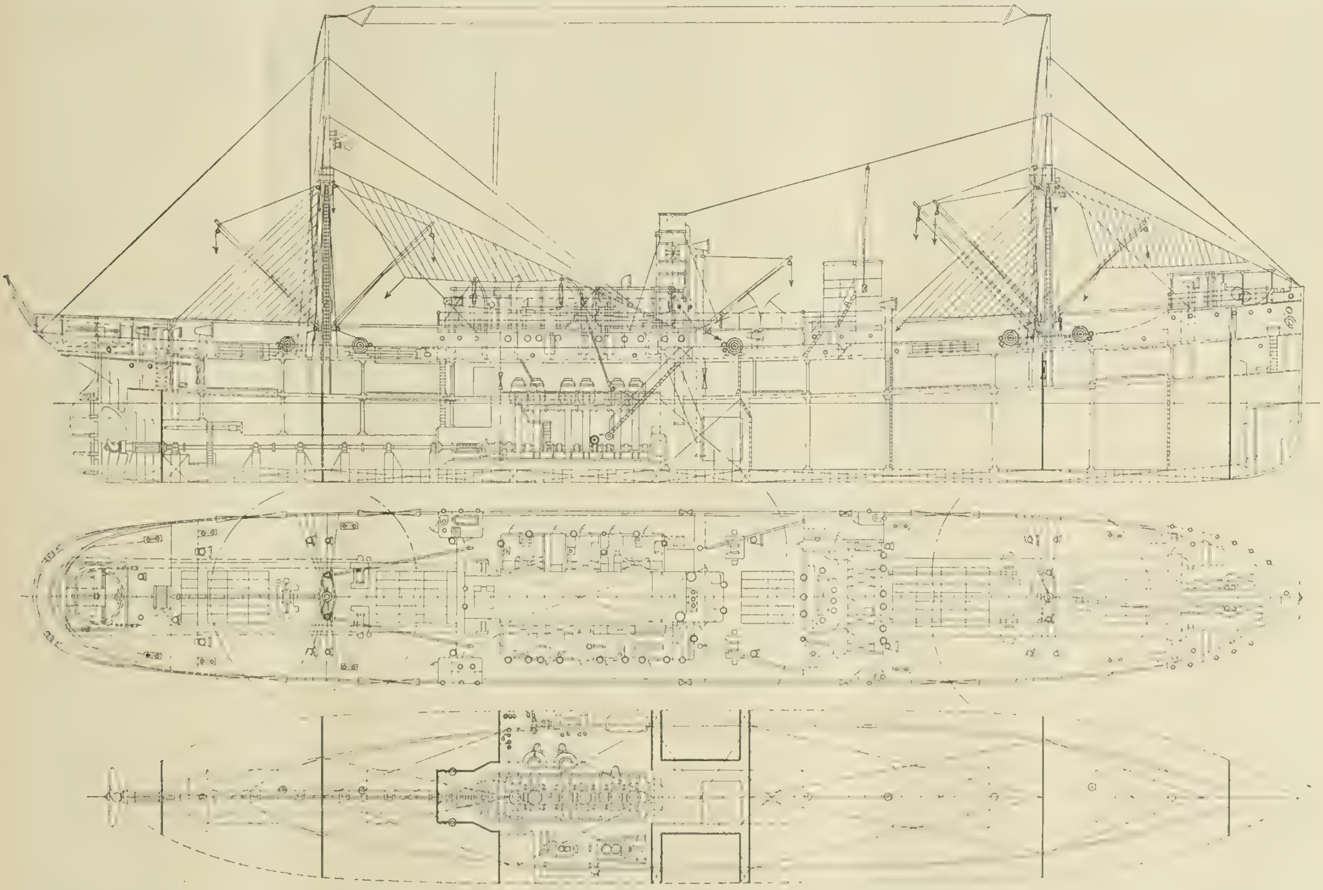


FIG. 3.—PROFILE AND DECK PLANS OF THE ROLANDSECK

are no fewer than four scavenging valves per cylinder. There does not seem any particular reason for such a large number, unless it is to avoid the excessive diameter fore and aft of larger valves. There is a great tendency among marine Diesel engineers to scavenge the combustion chambers by means of ports, with perhaps one valve in the cylinder head for ensuring efficiency. With the Junkers engine scavenging is carried out entirely by means of ports in the cylinder walls, which are uncovered as the opposed pistons are at points farthest away from each other. With *Rolandseck's* engine the fuel injection valve is also indirectly worked by its rocker, and an arrangement is fitted by which the secondary lever can be lifted clear of the valve stem, when starting or running on compressed air from the reservoirs. The latter are always kept fully charged, by means of an automatic maneuvering valve on the compressor. This obviates the constant attention of the engineer to the reservoirs, and the result would be serious if the reservoirs happened to have been allowed to run down just when an order for full speed astern had been signaled from the bridge.

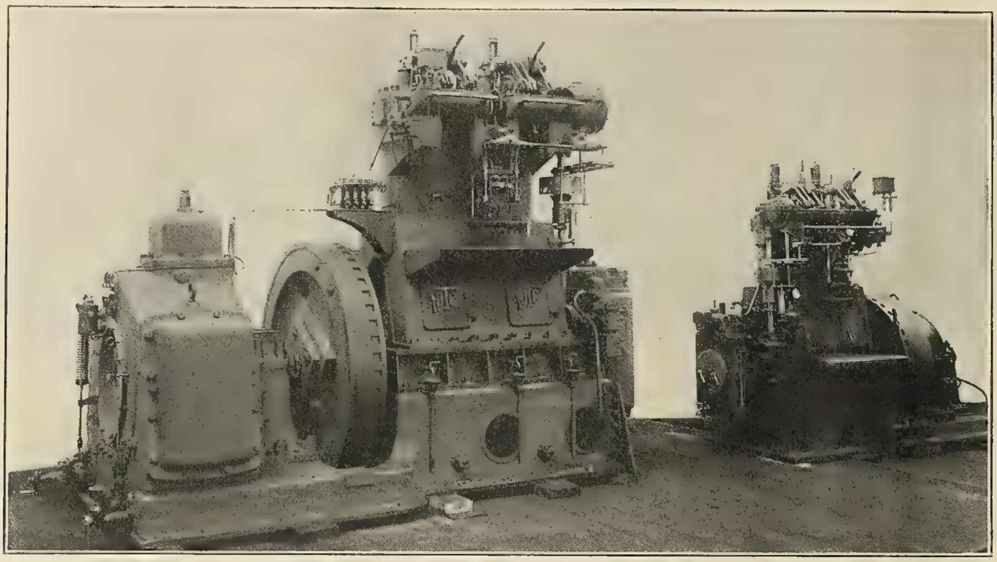


FIG. 4.—MOTOR-DRIVEN AIR COMPRESSOR AND GENERATOR FOR THE ROLANDSECK

Reversing is carried out by shutting off the fuel, and by means of compressed air or by hand the camshaft is turned to an angle relative to the crankshaft. The air starting valve is then opened in the cylinder, the piston of which is nearly at its highest point and the crankshaft rotated in the opposite direction. Fuel is then automatically turned on and the engine immediately picks up the load and continues running astern until re-reversed. There is, by the way, a separate fuel pump to each cylinder, the suction valves being controlled by the engine governor. The horizontal control rod from the latter can be seen below the cam and maneuvering shafts. This control rod is also operated by means of a hand lever.

If one may judge from the few two stroke engined ocean-going ships built, engine room auxiliary machinery will be of the four stroke type. *Monte Penedo's* main engines are two stroke Diesels, but her auxiliary motors are of the four stroke class, and the same can be said of the *Rolandseck*. She has two auxiliary compressors, one oil-fired steam driven, and another worked by a two-cylinder four stroke 100 horsepower Diesel motor of the enclosed type. The other auxiliary illustrated, it will be noticed, is coupled to a dynamo generating 110 volts at 160 amperes at 300 revolutions per minute, the driving unit being of 30 brake horsepower. This is used for the lighting of the ship and for feeding a motor, which turns a ballast pump of 100 tons capacity. An auxiliary boiler, oil fired, is installed for the windlasses, steering gear and heating of the vessel. There is also some minor auxiliary machinery. The total weight of all the propelling machinery and auxiliaries is in the neighborhood of 150 tons, and the bunker space gained allows of considerable extra cargo being carried. The donkey boiler is arranged at the forward end of the engine room, while on either side is a fuel tank, the two having a combined capacity of over 150 tons. The *Rolandseck* has been provided with a funnel amidships, to which the exhausts and the flue from the donkey boiler have been carried, so there is nothing in her outward appearance to distinguish her from an ordinary cargo steamer.

Fuel Oils for Use in Marine Diesel Engines

It has been proved definitely, not only by very rigid tests made for this specific purpose, but also by the actual operation for a reasonable period of time of Diesel engines in service, that oils suitable for use in Diesel engines may be said to cover a very wide range of contents. It is evident that out of the many different kinds of oil available, some will be found to be successful in certain types of Diesel engines, while others will fail to give satisfaction, and as it is not always possible to obtain the best kind of oil at every port where the ship may touch, some limitations must be fixed or trouble will ensue from the selection of the oil.

The subject should really be treated from two viewpoints. First, the grades of oil that can be successfully used in the Diesel engine, and, second, the source of supply available for ships in service. A recent continuous test was made by one of the large Diesel engine builders on oil having the following analysis:

Specific gravity, .947; flash point, 180; fire test, 226; viscosity, 237; water, 2 percent; sulphur, 3.6 percent; asphalt, 20 percent; B. t. u.'s per pound, 18,000.

The results of this test showed that from half to full load successful operation and complete combustion is easily attained, but while the engine is running light or with no load there is incomplete combustion and a resultant effect of precipitation of unburned oil on the piston and cylinder walls. This is not, however, a sufficient reason to reject the use of this oil, as it would only necessitate that the pistons be taken out and cleaned at least four times a year. With the higher percentage of asphalt there is also some accumulation of soot in the exhaust pipe, which, however, can readily be taken off. The frequency of cleaning the pistons in the exhaust pipe will, therefore, be dependent upon the load conditions under which the engine operates. Where oils having a high percentage of asphalt are used under conditions that would subject this oil to low temperatures, it would be necessary to provide an auxiliary to heat the oil, so that it will pass through the small feed pipes to the pumps of the engine cylinders.

In considering the adoption in marine engines of oil corresponding to the above analysis, it should be noted that the engines should be of the two-cycle type which are not provided with exhaust valves, as it is the exhaust valves which suffer the most from bad fuel and from high temperatures, which are the result of poor combustion. This oil would offer no difficulties for use in marine engines when a ship is at sea and running at a normal load, but under the conditions arising when the ship is entering or leaving port, so that very low load is required from the engine, it would be advisable when using a very heavy oil with a high percentage of asphalt to have on hand a small supply of a more volatile oil for use in starting the engine.

The types of engines should be considered in relation to the grades of oils that can be used, and especial care should be taken to see that the atomizers of the engines are of such an accessible type that they can be taken apart readily and cleaned or adjusted for oils of different consistencies. On the whole, it would seem advisable to have a fuel pump supplied for each working cylinder, so that with the proper connections and valves the supply of oil may be changed from the cheaper heavy grade to the light or gas oil.

From the second viewpoint the Mexican oil fields can be said to have only just begun to show their possibilities. In 1911 there were only about 800,000 barrels of oil shipped from the Mexican fields, while in 1912 there have been approximately 6,000,000 barrels of crude oil shipped from Mexico, and yet the field has hardly begun to be developed. When the records show that there are wells flowing from 18,000 to 30,000 barrels per day, it can readily be seen that this field can be depended upon for a great volume of oil. The California oil fields, on the other hand, while developed to a great extent, show a production of something over 87,000,000 barrels of oil in 1912, with a large number of wells capped and not permitted to flow. It would seem possible to expect 100,000,000 or more barrels of oil available from this field per year. With these two great sources of oil, one available on the east coast and the other on the west coast, and with the completion of the Panama Canal near at hand, American merchant ships can at least feel assured of a dependable supply of oil being available for marine service. A factor that enters into this question of the supply of fuel oil which is of great interest to the shipowner is that, with the low fuel consumption of the Diesel engine for any given service, it is possible to take on a cargo of fuel oil for a very long passage without touching at any port for an additional supply. At least two instances proving the value of this can be found in the East Asiatic Company's ships, plying from Northern Europe to India, taking on fuel cargo for the entire voyage in India at a point where it can be bought at the lowest price, and in the case of the *Fram*, which, under the command of Captain Amundsen, made the record trip in his South Polar explorations without suffering any difficulties from the lack of fuel.

In conclusion, it might be said that if Diesel engines are being built for marine service of such types and with proved reliability they can be applied to the merchant marine service with great benefits accumulating in favor of their use in addition to their low fuel consumption, they certainly deserve serious consideration by shipowners, for by this low fuel consumption there is offered a means for aiding in the conservation of the supply of oil now available or that may be available in the future.

NEW RAILWAY DRYDOCK INSTALLED AT HARBOR GRACE, NEWFOUNDLAND

New Railway Drydock Plant

An interesting railway drydock plant, designed especially with the object of docking a large number of vessels during a short period of time, has recently been installed by the Crandall Engineering Company, East Boston, Mass., for the Marine Railway Docks Company, Harbor Grace, Newfoundland.

The plant consists of two railway drydocks placed side by side at a distance of 42 feet between their centers. The larger one is 600 tons deadweight capacity, the cradle of which is divided into two parts. The forward is 70 feet long and the aft 90 feet long over the keel blocks, with a width of 38 feet over the deck logs. The keel blocks are placed 6 feet centers and the bilge blocks 12 feet apart. On the upper cradle are placed four sliding bilge blocks on each side and on the lower six, all being operated by chains and winches from the docking platforms.

The smaller drydock comprises two separate cradles traveling on the same set of tracks. The forward cradle is 60 feet and the aft 80 feet in length over the keel blocks, with a width of 34 feet over the deck logs. The capacities are 300 tons and 250 tons deadweight respectively. The keel blocks are 6 feet centers, and there are four bilge blocks each side for the upper and five for the lower cradle, operated in a similar manner to the larger one. All cradles are fully decked, and when hauled high and dry above the water, the height of deck from the water is 2 feet.

By this method of dividing the cradles, they may be so arranged that each one may be operated as a unit or independently. When operated independently four vessels may be hauled at one time, but they must necessarily be of lighter weight than could be hauled if the cradles of each dock were connected together.

The general dimensions are as follows:

	No. 1	No. 2
Capacity deadweight	600 tons	550 tons
Length over keel blocks	160 feet	140 feet
Length over each cradle	70 & 90 feet	60 & 80 feet
Draft of water over keel blocks at mean high water	10 & 15 feet	9 & 15 feet

The time of hauling a vessel fully up is about fifteen minutes in each case.

There are two sets of hoisting machines which are worked by one 8½-inch by 10-inch double engine. They are so arranged that each can be operated independently of the other. The hauling chains are of the long link type and made especially for this class of work and under the stiffest of chain specifications. The sprocket wheel is cast steel and the gears are all machine molded. The machine foundations and the struts from foundations to the head of the track are built of concrete reinforced. The track is of timber with pile foundation. Protection against the teredo is provided for by a thorough sheathing with creosoted planks placed over ship's felt and securely fastened to the track.

Marine Engineers' Convention.—The thirty-eighth annual meeting of the National Marine Engineers' Beneficial Association was convened at the New Charleston Hotel, Charleston, S. C., Jan. 20. The former officers of the association were re-elected for the ensuing year. William F. Yates, of New York, is president, and George H. Grubb, of Chicago, is secretary. The next annual meeting will be held at Washington, D. C., in January, 1914.

New Russian Submarine

BY F. C. COLEMAN

The Russian naval authorities have, during recent years, experimented with almost every design of submarine, with probably the single exception of the French boats. Considerable use has been made of the German-built boats, and, so far as speed requirements are concerned, the Bubnoffs and Beklemischeffs head the list, a speed of 15 knots under water being claimed for this design of intermediate-sized submarines.

The latest addition is a flotilla of three diving boats—*Karp, Kambala and Karas*—built at Fried. Krupp's Germania yard, Kiel. The first Germania boat built for the Russian navy was a 17-ton vessel, the experimental boat, *Forelj,* which saw some war service with the submarines which followed her in the Far East seas—the *Som, Delfin, Kasatka, Nalim, Skat, Osetr* and *Scheremetief*. The above-named submarines gathered during the war at Vladivostock, and those which arrived near its end—*Bishop, Paltus, Ploto* and *Shuka*—might have proved a better weapon if bad luck and want of organization had not frustrated the efforts of the officers in charge of them.

RUSSIAN SUBMARINE KARAS ON A SURFACE RUN

But some of the boats gave some trouble—the *Delfin* was damaged by an explosion and the *Nalim* sunk. The experience gained with the *Forelj* may be said to be partly responsible for the order of three Germania diving boats, embodying on a larger scale the same principles experimented with in time of actual war with their small predecessor.

The general appearance of the new Russian submersibles is shown by the accompanying illustration, which represents the *Karas* at a full-speed run on the surface. One of the cardinal virtues aimed at in the design has been seaworthiness, and besides this great stability and radius of action and quick diving are claimed for these Germania boats. The dimensions of *Karas* and her sister ships are:

Length, overall, 131 feet; breadth, 10 feet; draft, surface, 8 feet 2 inches; surface displacement, about 196 tons; submerged displacement, about 236 tons; armament, one 18-inch torpedo tube and three torpedoes; surface speed, 11 knots; submerged speed, 9 knots.

Propulsion by means of electromotors when submerged, and by petroleum motors on the surface. The Germania boats burn ordinary petroleum, a fact which practically eliminates all danger of explosion. Another source of danger is minimized by the disposition of the fuel tanks outside of the ship's hull.

These boats, after having undergone their official trials, were manned by Russian crews and performed a series of interesting trials in the bays of Kiel and Eckernförde. At the conclusion of these experiments they left Kiel for Libau, and reached that port in about 50 hours, thus averaging 8.33 knots flotilla speed. This performance, though it does not break the "UI" record—Kiel-Heligoland, 600 miles—as far is sea-going speed is concerned, is of particular interest, as the speed attained is of a tactical group of three units.

Port Facilities for Ships and Cargoes*

BY WILLIAM T. DONNELLY

Port facilities for ships and cargoes form the most important link in the world's transportation, which, broadly speaking, is perhaps the most important activity which engages man's attention. Port facilities embrace the harbor, piers, railroads, floating harbor equipment and all the minor appliances, such as storage, rehandling and transfer facilities. When we look for the most important factor or controlling feature in the problem, we find it to be the ships by which the transportation is effected. The vital principle and earning power in transportation is the movement of vessels and cargoes from one place to another.

The fundamental difference between European and American ports is that nearly all of the great ports of European countries are a considerable distance from the sea, while most of the ports in the United States and Canada are on the seacoast. This brings about an entirely different situation relative to the port facilities. Therefore, it is not practicable to compare the port of Hamburg with the port of New York, and the methods and devices used in the one city are not at all adaptable to the other.

Another fundamental difference is the fact that, while the port of New York is by far the largest of any in the world, it is not the home port of any of the great transatlantic steamship lines, and it is very plain that a company owning ships will make greater investments for port facilities at a home port than at a foreign one.

Perhaps the greatest difference between the port of New York and any of the foreign ports is the extent to which lighterage is used in this port. Manhattan Island is reached direct for freight purposes by only two of the many railroads that reach the harbor front, and access to and from Manhattan Island, Long Island, Staten Island and the adjacent waters is brought about by a very extensive system of harbor transportation known as lighterage, by which all kinds of both rail and water transportation is moved to and fro at a minimum cost and with the greatest flexibility.

A part of this transportation is the system of car floats or the handling of railroad freight cars upon floats or barges built and used for that purpose only. These car floats were originally designed solely for ferrying purposes, but it was soon discovered that they formed one of the most flexible devices for freight handling in and about a large marine terminal, and they must now be considered one of the most important features of the port of New York. In fact, so valuable are they to the railroads that piers devoted exclusively to the loading and unloading of cars on floats have been taken over one after the other along the lower part of Manhattan, until at the present time this diversion of the piers to railroad business sorely vexes our dock commissioner.

When the American piers are considered relative to the piers of foreign ports, the principal difference is the absence of heavy lifting machinery, which is always a very prominent feature of the foreign ports. This has been brought about by the adaptation of floating derricks for handling all heavy weights from lighters to ship's hold and from ships to lighters, and then to the pier head and bulkhead for rail transportation or delivery in the city. The development of this particular branch of our transportation is an American feature and owes the extent of its development very much to apparatus primarily designed and developed for wrecking purposes.

In the practice of this port, only the lighter portion of the cargoes are handled over the ship's side on to the piers—that is, objects weighing a maximum of two tons, such as are readily handled by ship's winches and similar winches on the pier. A fixed or traveling crane located on a pier can serve but one ship, and often not more than a single hatch of that ship, while a floating derrick or lighter may move from ship to ship and from one part of the harbor to another and find very much more constant occupation.

A great deal of consideration has been given to the matter of bringing the railroad and steamship close together, but wherever this has been tried out it has not been found to be practicable. Many piers are built with railroad tracks running down the center, but very few cars will be found at any time on the piers. This is largely owing to the fact that a freight car is a very awkward object to move about, and that it contains a comparatively small quantity of goods; also, that the shifting and moving of the freight cars interfere very much with the work of handling material on the pier. Of course, this does not apply to goods that can be delivered in carload lots, such as grain, coal and ores, for such materials do not come to the steamship piers referred to, but to special piers devoted entirely to their reception, where they are handled by machinery at as low a cost in this country as anywhere else in the world.

The coaling of ships in this port is of a somewhat unusual character, and to a certain extent affects the methods of freight transwer. Coal is brought to the ship's side in canal boats containing from 400 to 600 tons. To expedite the coaling it is done on both sides of the ship—that is, first on the offshore side and then the ship is breasted out or moved some 20 feet or 25 feet from the pier, the coal boat moved in between the pier and the vessel, and the bunkers filled on that side.

It is apparent that cranes fixed on the pier during this time would have to extend or over-reach some 25 feet further, while the ship's winches, working in connection with a similar winch on shore, can transfer freight without interruption. These winches are designed to handle from one to two tons on a single line, and to be operated by the ship's crew and with whatever assistance is necessary from the shore. Small packages are aggregated in the familiar rope netting and form packages, such as boxes and barrels, are readily handled in the aggregate in slings.

From an extended familiarity with this work, it would seem that there is little probability of any other mechanical appliances superseding this method in this port, when freight is to be hoisted from a ship's hold. When freight can be delivered from a gangway at or below the pier level, mechanical devices to assist stevedores with hand trucks on grades have been found practical, and these devices are also much used to and from lighters which bring a considerable amount of material to the piers for storage and transshipment to vessels.

Ordinary freight elevators, inclined elevators and slideways are used to move material from one level of a pier to another, and various overhead telpherage systems are used for handling and tiering, but these mechanical devices must be carefully

* Abstract of a paper read before the American Society of Mechanical Engineers, New York, February, 1913.

studied to meet known and special conditions, and very serious mistakes can and have been made by only a one-sided understanding of the situation.

Any device which will assist a longshoreman in his work with the familiar two-wheel truck can find a place, but any device which would tend to replace or eliminate him from the package freight handling problem must be looked at with very great care and some distrust.

The coaling of ships from canal boats in this port is a slow and tedious process, requiring from ten to fourteen men in a boat shoveling coal into tubs, and an equal or greater number in the bunkers distributing the coal, the rate of loading being approximately 25 or 30 tons per hour, which is strictly limited by the rate of trimming the coal inside the ship. A number of attempts have been made to replace the cost of this work by a more extended application of mechanical means, and some progress has been made, but the fact that the coaling of the boats is, as far as possible, made a secondary consideration to the handling of freight, and must often be interrupted, has been a stumbling block to any decided advance in this direction.

No discussion of port facilities would be at all complete without some consideration being given to the matter of facilities for getting the freight to and from the steamship piers; that is, should the railroads deliver the material in cars on piers or to the terminal adjacent thereto, and to what extent and how should the railroads and waterfront be tied up together?

New York, which, of course, is by far the largest commercial port in America, and, for that matter, in the world, has examples of both the worst and best arrangement of marine and rail transportation. The Atlantic freight and passenger transportation commenced to and from the port of New York, and has found its continued and greatest development in connection with the west side of Manhattan Island, and it is over this waterfront, as the business developed, that it has been necessary to transfer between ship and railroad and ship and factory vast quantities of merchandise.

Owing to the fact of its isolation, this waterfront was reached by but a single railroad—the New York Central—and this remarkable condition continues up to the present time, and has been very much aggravated by the fact that it was necessary to connect this shore front with the terminals of other railroads across the Hudson by a great many passenger ferries, and the history of the west side waterfront of New York is that of a contest between the rail transportation interests to keep a railroad right-of-way along the waterfront and the people of New York to have it removed on account of danger to life and limb.

In the meantime, the Atlantic transportation business has steadily grown and congestion along the waterfront has been steadily increasing. To meet this, the railroads terminating in Jersey City have adopted the practice of leasing the piers along the lower Manhattan waterfront and using them for the receipt and delivery of railroad freight, which, of course, results in the exclusion of transatlantic and coastwise commerce from these piers. This condition is quite satisfactory to the railroads, but is looked upon with very great disfavor by the steamship lines and also by the Dock Department, which has at heart the best interest and most desirable use of the waterfront for marine transportation. It also results in a very great congestion of the piers and West Street from trucks bringing and removing freight.

An independent study by private parties of these conditions some time ago resulted in the most remarkable industrial development that any city has ever seen. I refer to the Bush Terminal in South Brooklyn. The Bush Terminal Company made a study to bring about in connection with the waterfront a condition similar to that prevailing outside of New York City; that is, they provided on the waterfront float bridges where not only one, but all the railroads could deliver freight cars to shore tracks, and a car distributing yard on their own property, from which the cars could be delivered as required alongside factory buildings, so as entirely to eliminate trucking charges and, what was still more important, unnecessary delays and confusion in shipping.

The company also created a system of piers backed up by storage warehouses for the receipt and storage of raw material between producer and factory, and also for the storage of finished material to be accumulated for shipments abroad. The result is that we have on the South Brooklyn waterfront the most perfect system of rail and marine freight handling, manufacturing and redistribution that has been accomplished to date anywhere in the world. All confusion and interference has been eliminated and congestion is unknown, and the general plan is being studied and copied in many parts of the United States.

Broadly speaking, there is no difference from an engineering point of view between the South Brooklyn and Manhattan waterfronts. The same arrangement applied to the Manhattan waterfront would bring about just as satisfactory a solution of the problem. The only added complication is the fact that great numbers of people must have access to the Manhattan waterfront, and it has been the contention that their safety is of the first importance, and that consequently no additional railroad facilities should be allowed upon that waterfront, and even those existing should be removed, and to this end the Dock Commissioner has prepared an elaborate plan for removing the railroad tracks from the surface to an elevated structure, this structure to be extended along the waterfront and to be accessible to all railroads. To my mind, there seems to be an almost insurmountable difficulty to this plan; that is, the grade to be overcome in raising the cars from the water level to from 25 feet to 30 feet above, and the additional very great expense of supporting freight cars and locomotives upon an elevated structure. Primarily, it would seem that the object to be attained is the separation of the passenger and freight transportation, and it would appear that this could be brought about at very much less expense by elevating the passenger traffic at and along the waterfront; that is, treat the Manhattan waterfront in exactly the same manner as the Brooklyn waterfront, and then, for the passenger traffic which must be provided for, create an elevated street or highway adjacent to and along the front of the piers on West street, this elevated street to be used exclusively for foot passengers and vehicles for passenger transportation, to be reached at various points, which might be every third or fourth block, by ramps of such a grade as to be unobjectionable to foot passengers and vehicles, but very much greater than could be used for rail transportation.

It would then be possible to give all the railroads free access with cars to West street and eliminate all danger to foot passengers. The railroad and terminal companies would then take and develop the property on West street, now of comparatively little value, in a similar manner to that in South Brooklyn, and the cars would be run from West street directly into these terminals for loading, and the car floats would disappear from the waterfront except at the float bridges.

The one precaution that should be taken would be not to allow cars on any streets extending back from the waterfront; that is, to force all rail connections to terminals through private property and reserve the street exclusively for ordinary traffic. The practicability of foot passengers going over, rather than across, West street at grade has been shown by the private footways at the foot of Liberty and Cortlandt streets, and it is a well-known fact that nearly all access to and from passenger steamers is from the upper decks of piers. The elevated highway along West street would not only remove the foot passengers from the wet and dirt inseparable from the waterfront, but would provide a very much needed highway north and south exclusively for passenger traffic. It is hardly necessary to point out to engineers the very great saving in the cost of such a structure over one necessary to carry and distribute freight cars.

The foregoing is not offered as a criticism of the elaborate terminal plans so thoroughly worked out by the Dock Department, but as a suggested modification which would make the plan as a whole more possible of execution by avoiding the three percent railroad ramp or grade on West street, with a sharp curve at the foot.

By this modification it would also be possible to distribute the car-float bridges along the waterfront, which it is believed will be much more practical than to have them all at one point. It might be added that there is ample room on West street for the present street car tracks next the West street sidewalk, then four railroad tracks, and beyond a sufficient width of street surface to allow for ready access of trucks to the piers.

Marine Turbine Operation and Economy*

BY LIEUTENANT-COMMANDER H. C. DINGER, U. S. N.

Points in Securing Economy

Dry Steam.—It is evident that moisture in the steam has a bad effect on the economy of the turbine. It is therefore essential that the design and management of the boiler plant be such that dry or slightly superheated steam is furnished. The use of steam domes on the boiler of torpedo vessels appears to be desirable. Water tenders should be trained to carry continually a uniform and safe water level and to guard against carrying a high or fluctuating one. The use of superheated steam would appear advisable in cases when the blading will permit its use.

Vacuum.—Economy is largely dependent upon the vacuum. Every turbine installation should have a vacuum augmentor or some form of dry air pump whereby a vacuum within one inch of the barometer can be maintained with circulation water at 70 degrees F. Experience has demonstrated the augmentor to be generally more reliable and simpler to handle than the dry vacuum pumps. Even with a proper condensing apparatus and air pump, the vacuum may be adversely affected by the following:

1. Leakage of air through turbine glands. The turbine glands are usually packed with auxiliary exhaust steam or other steam of reduced pressure, and care must be taken to see that a pressure above the atmosphere is carried on the glands at all times. For this reason the pressure gage on the gland system must be frequently tested for accuracy. One or two pounds pressure on the glands is sufficient, but you must be sure of having this pressure. When cruising turbines are cut out, but shafts not disconnected, special care must be taken to see that proper steam pressure is on the glands, because under these conditions the cruising turbine is running in vacuum and the opportunity for air leakage is much greater. Care must also be taken to see that the leak-off to the condenser is open only when necessary. With the leak-off open to the condenser, the whole system is bled of steam and ordinarily the leak-off to the condenser can be closed.

2. Air leaks in piping and exhaust connections. These leaks may be anywhere in the ship and the most careful watch must be kept on them. A small drain connection left open may reduce the vacuum by a half inch or more. It is preferable to run all drains, exclusive of turbine drains, to feed heaters, feed tanks or auxiliary condenser, so as to avoid any possible air leaks into the main condensers.

3. Condenser air bound on water side. This may be remedied by providing an air cock near the top of the water space and keeping it slightly open.

4. Tension on springs of air pump valves. Usually the tension on the springs of the foot valves of the air pumps is considerably more than is necessary to properly seat the valves. Slacking back on the valve springs will in many cases result in gaining a quarter to a half inch of vacuum.

* Concluded from the February issue.

5. Condenser tubes choking up. Condenser tubes from time to time choke up with seaweed or other matter drawn in with the water. When tubes are thus plugged they are rendered inoperative for condensing purposes. Regular and frequent examination will prevent any serious choking of tubes.

6. Exhaust joints not tight. The manner of making joints in exhaust lines is of great importance. The very greatest care should be exercised on the making of these joints. Painting the edges of joints with shellac has been found to be a serviceable method of stopping a small air leak.

Vacuum is almost everything in turbine economy, and it is often most difficult to get machinery attendants to realize it. Eternal vigilance is necessary. A small air leak, here or there, hard to locate, soon will mean tons of coal lost. A vacuum within an inch of the barometer can be maintained if all leaks are cut out, and anything short of this should not be accepted as satisfactory.

Dummy Clearances.—These must be constantly watched. If they become too great, there is a loss in economy. If too small the dummy rings will touch, parts may tear out and the turbine be wrecked.

The low-pressure dummies are arranged so as to have from twenty to thirty thousandths of an inch average clearance. This, with six to eight thousandths float, will give actual readings from fourteen to thirty-six thousandths, and in special cases limits outside of these will be obtained. This amount of clearance is necessary for safety. As the low-pressure shafts take propeller thrust and also have the reversing turbines and the largest rotor, it may be said that a reading below ten thousandths should never be allowed on a low-pressure and astern turbine.

On the high-pressure turbine the leakage will be relatively greater for the same clearance. The rotor is not as large, and hence a lower clearance may be permitted. If there is a reversing turbine on the same shaft the clearance should not be allowed to go below eight thousandths. If there is no reversing turbine the limit may be six thousandths.

The cruising turbines take no propeller thrust, and if the flexible coupling between the cruising and the main turbines can be depended upon a less clearance can be allowed. For cruising turbines, six thousandths should be the least clearance allowed.

The personal error of taking a reading of dummy clearance should not be over two thousandths, hence with six thousandths as the limit there is sure to be three or four thousandths clearance. It must, however, be absolutely known that at these minimum readings the rotor is actually in up against the thrust collars and the thrust adjusting ring; for if these low readings are obtained and the rotor can come in still further, a dangerous condition is presented.

If you are positive that the rotor is all the way in, and that the readings are accurate, clearances of one or two thousandths are all right. On the other hand, if you are not sure that the rotor is in, a clearance of ten thousandths may be dangerous.

For very large turbines somewhat larger clearances should be allowed. It is, however, believed that a larger average clearance than thirty thousandths on low-pressure, twenty-five on high-pressure and twenty on cruising turbines should not be permitted if good regard for economy is taken.

Lubricating System.—Perhaps the most important thing in connection with operating a turbine plant is the lubricating system, and efficient lubrication has an important bearing on turbine economy.

The oil must be kept absolutely clean and free from water. When oil is received, it should be strained through several thicknesses of muslin, or, better, through chamois skin. The entrance of salt water into the lubricating system must be carefully guarded against. Salt water can enter from a leak in the oil cooler or from using salt water on bearings. The use of salt water for cooling bearings should not be permitted, since once salt collects in a bearing, that bearing is very liable to be cut and scored.

Water and dirt will collect to some extent, even if the greatest care is taken, and when standing idle the water and dirt will gather in the lower part of the bearings. The water may cause a little rust to form which may cut the white metal, and the dirt will do the same. To guard against this the oil pump should be put on the lubricating system for a short time each day, so that the oil in the system is moved along and the water and dirt will not have such a good opportunity to collect.

In order to get rid of the water and dirt in the system, the bottom layer of oil in the drain tank should be drained off each day. This mixture of dirty oil and water may be filtered and used again, but it is not advisable to use such filtered oil except in auxiliaries. After every two months the oil drain tank should be completely cleaned out and the lower half of the oil filtered or treated. In order to cause the oil and water to separate, the oil in the tank should be heated. This can be done by putting a small steam coil in the drain tank. The dirt which collects in the oil consists of impurities in the oil, rust from the journals, small particles of metal worn off bearings or journals, and loose matter laying in the piping or other parts of the system. After a period of use the lower layers of oil in the lubricating oil tank will form into a more or less gummy mass. Straining and filtering the oil, heating and letting it stand, will remove this condition. It has been found that after a lot of oil has been in use for some time, its lubricating value is reduced, and that if this oil is allowed to settle and stand for a period of several weeks it will tend to regain its lubricating value.

With a good forced lubricating system, carefully looked after, very little oil is lost. That drained off from the bottom can be used for auxiliaries, so that the leakage is practically the only loss. A destroyer of 15,000 shaft horsepower has been known to run on an expenditure of less than 10 gallons a month, while steaming 3,000 or 4,000 miles during this time, and a battleship has run for three months, making 4,000 miles on an expenditure of 250 gallons. The pressure used on the forced lubrication system is an important matter, affecting oil expenditure. If a high-pressure is used leakage will, of course, be increased. With a properly designed system a pressure of 5 to 8 pounds in the discharge pipe from the cooler to the bearings should be sufficient.

Oil Cooler.—The design of the oil cooler should be such as will not introduce any considerable resistance, and thus necessitate carrying a high oil pressure at the pump. In some designs considerable resistance and consequent necessity for carrying a high-pressure at the oil pump is encountered.

Ring Oilers.—The practice of using ring oilers entirely separate from the forced lubrication system for all line shaft bearings is very satisfactory. This arrangement reduces the amount of piping and fittings in the system under oil pressure, and hence greatly reduces the leakage. The ring oilers have been found to be very satisfactory and give no trouble, only requiring occasional cleaning out and renewal of oil.

Methods of Observing Oil Temperatures.—A very important matter is the position of the thermometers on oil bearings. These should be in places where they can easily be read, for if it is difficult to get at them they will often not be looked at when they should. A very satisfactory arrangement is that employed on Parsons installations, built at the Bath Iron Works. The returns from the various bearings all lead to a manifold immediately above the oil drain tank. The manifold has a glass top through which the stream of oil from each bearing can be seen. A thermometer is placed at the end of each return pipe close to the manifold. One man standing in one position can thus observe the streams of oil and note the temperature. As soon as any bearing warms up it is noted immediately, because all the thermometers are under observation all the time. The matter of observing temperatures of bearings is thus greatly simplified. When carefully laid out the manifold system requires no more piping and fewer fittings than when a separate sight glass and thermometer is at each bearing.

Use of Auxiliary Exhaust.—The use of auxiliary exhaust in the turbines adds considerably to the economy. The exhaust should, of course, be used on the feed heater, but all excess that the feed heater cannot utilize should be used in the turbines. There are usually several connections, so that the auxiliary exhaust can be turned into different parts of the turbine installation. It is usual to have a connection to the intermediate turbine. This can be used at low cruising speed when the pressure in this turbine is below the pressure carried in the auxiliary exhaust pipe. Then there is usually a connection in the low-pressure turbine. This connection can be used at high powers. In some installations there are additional connections for admitting an exhaust into the third or fourth exhaust of the low-pressure turbine. This allows the exhaust to be used at still higher powers. At near full power the pressure in the turbines, at the connections, is sometimes above the pressures that can be carried in the exhaust pipe and under these conditions the excess auxiliary exhaust must be put into the condenser.

The auxiliary exhaust should always be used in that part of the turbine whose pressure is slightly below the pressure in the auxiliary exhaust line. Care must be taken that the pressure at that stage is below and not above the pressure in the auxiliary exhaust, for otherwise steam may be taken out at the turbine.

The question of whether it is better to use the auxiliary exhaust in the lower stages in the turbine or in a feed water heater is sometimes debated. Both theory and practice show that there can be no question but what it is more advisable to use this exhaust for feed heating, or rather use the amount necessary to heat the feed water to the highest temperature that the heat in the auxiliary exhaust will give. When using the auxiliary exhaust in the feed heater it is theoretically possible to abstract about 100 B. t. u. per pound of the steam. When used in the low-pressure turbine only about 25 B. t. u. per pound of steam can be extracted. With proper feed heaters very nearly theoretical results can be obtained. Now, of course, only the amount of steam required to heat the feed water up and the temperature obtainable with the pressure in the auxiliary exhaust should be used in the feed heater. Any more than this is simply wasted and should be used in the turbines. Therefore, the practice should be to use such of the exhaust as is needed to heat the feed, and use all the remainder in the turbines.

In order to get all the heat possible out of that used on the feed heater, the drain from the feed heater should have an efficient trap or water seal and drain to the feed tank. There should be an air connection to the steam side of the heater to keep air from collecting and the heater should be carefully watched to keep it from flooding.

The feed to the boilers should be as uniform as possible in order that the rate of flow through the heater may be uniform, and so that the maximum temperature of feed can be held at all times. This is a matter that may often be overlooked, but a uniform feed will probably give from 5 to 10 degrees higher average temperature of feed than an irregular feed will give.

Losses from Leaky Valves.—This is one of the principal fields for lack of economy. If any of the throttle valves or the non-return valves between the high-pressure cruising and intermediate-pressure cruising, or intermediate-pressure cruising and main high-pressure, are leaky, there is a loss. If all these valves are leaky the loss may be very considerable. The valves between the high-pressure cruising and intermediate-pressure cruising and the intermediate-pressure cruising and main high-pressure are often caused to become leaky due to hammering on their seats when warming up or in maneuvering and slowing down. It is also very important that the various drain valves and leak-offs be tight, since leakage through these is a direct loss to the condenser.

The valves which admit the auxiliary exhaust into different points of the turbines must also be tight. If these are leaky they may act as a bypass around the turbines, and possibly to the condenser.

The large throttle valves and non-return valves between the turbines when fitted with cone seats are practically impossible to keep tight, owing to the unequal expansion and consequent distortion of the seats when heated up. Therefore flat-seated valves and preferably flat flexible valve disks would appear to be better suited for this service. The degree of tightness of these valves has a most important bearing on the economy of the plant.

Use of Most Economical Combination.—In cruising at medium or low speeds it is important to operate the turbine combinations that will give the speed with the greatest possible economy, and the highest cruising combination should be used as long as it will give the power required. If near the limit of power of any combination, the bypass on the cruising turbine and the bypass on the throttle of the next lower combination should be opened. This will increase the power and still give greater economy than shifting to the next lower combination. Cracking the throttle valves of the lower combinations is not recommended, as it is liable to cause erosion of the valve and seat and thus bring about leakage.

Stand-by Losses.—Due to the necessity for having gland steam on and the large number of auxiliaries that have to be run, the stand-by losses with the turbine installation are considerably greater than is the case with reciprocating engines. Therefore the turbines and auxiliaries should not be kept in stand-by condition, ready to move, except when absolutely necessary. The turbines should not be made ready until a short time before they are required, and should be secured and their auxiliaries slowed down and secured as soon as possible after anchoring. Also maneuvering with turbines—that is, backing or calling for different speeds on the various shafts—is very wasteful, and if economy is desired such maneuvering is to be avoided as much as possible.

Summary of Points in Securing Economy

The following summary of points for securing economy may be given:

1. Highest boiler efficiency.
2. Dry steam and superheated steam where permissible.
3. Highest possible vacuum.
4. Reduction in dummy clearances to lowest limit for safe running.
5. Avoidance of leaky valves, such as throttle, bypass, gland steam and drain valves.
6. Use all excess auxiliary exhaust that cannot be used in feed heater in turbines.
7. Provide economical auxiliaries and operate them in as economical a manner as possible.
8. Maintain lubrication system in efficient condition.
9. Operate that combination of turbines which will be nearest to full power for speed required.
10. Avoid stand-by losses and maneuvering as much as possible.

By care and attention to all these points a very good economy can be obtained and even at very low powers results that approach close to those obtained by good reciprocating engines can be obtained. At low powers the steam used by the auxiliaries is the great factor. This must be reduced to the lowest limit possible, and all the auxiliary exhaust must be used to the very best advantage.

Use of Vapor for Evaporators in Low-Pressure Turbines.—An appreciable gain in economy may be realized by turning the vapor from evaporators (when distilling for make up feed) into the auxiliary exhaust line, and using this in the low-pressure turbines. In this way some of the heat which is otherwise lost in the distiller circulating water is made to do useful work in the turbine.

Use of Reheaters.—It is very likely that the employment of reheaters in the receiver pipes, between the high-pressure and low-pressure turbines, would result in an appreciable gain in economy. The steam for this purpose could be taken from the separator, or steam line drains, or from pockets on the lower side of the high-pressure casing, about half way down the casing. Taking the heating steam from these sources would serve to get rid of the moisture at the high-pressure end, and the heat in the moisture could still be utilized to dry the steam going to the low-pressure turbine.

Progress of U. S. Naval Vessels

The Bureau of Construction and Repair, Navy Department, reports the following percentage of completion of vessels for the United States Navy:

	Tons.	Knots.		Nov. 1.	Feb. 1.
BATTLESHIPS					
New York	28,000	21	Navy Yard, New York	62.5	69.6
Texas	28,000	21	Newport News Shipb'g Co.	79.2	84.3
Nevada	28,000	20½	Fore River Shipb'g Co.	10.1	19.6
Oklahoma	28,000	20½	New York Shipb'g Co.	9.3	14.9
TORPEDO BOAT DESTROYERS					
Henley	742	29½	Fore River Shipb'g Co.	96.9	100.0
Cassin	742	29½	Bath Iron Works	60.4	77.5
Cummings	742	29½	Bath Iron Works	52.7	68.5
Downes	742	29½	New York Shipb'g Co.	25.0	37.1
Duncan	742	29½	Fore River Shipb'g Co.	44.4	63.0
Aylwin	742	29½	Wm. Cramp & Sons	61.3	83.5
Parker	742	20½	Wm. Cramp & Sons	56.6	77.9
Benham	742	29½	Wm. Cramp & Sons	56.0	72.4
Balch	742	29½	Wm. Cramp & Sons	58.6	81.1
SUBMARINE TORPEDO BOATS					
F-4	....	....	Seattle Con. & D. D. Co.	94.6	94.6
G-4	....	....	Wm. Cramp & Sons	88.3	88.3
G-2	....	....	Newport News Shipb'g Co.	86.0	86.0
H-1	....	....	Union Iron Works	84.5	87.2
H-2	....	....	Union Iron Works	84.5	86.7
H-3	....	....	Seattle Con. & D. D. Co.	82.1	84.9
G-3	....	....	Lake T. B. Co.	60.0	61.9
K-1	....	....	Fore River Shipb'g Co.	54.2	65.5
K-2	....	....	Fore River Shipb'g Co.	53.5	65.3
K-3	....	....	Union Iron Works	59.0	68.1
K-4	....	....	Seattle Con. & D. D. Co.	54.5	66.1
K-5	....	....	Fore River Shipb'g Co.	38.6	48.5
K-6	....	....	Fore River Shipb'g Co.	38.1	48.5
K-7	....	....	Union Iron Works	42.0	55.6
K-8	....	....	Union Iron Works	41.5	54.1
COLLIERS					
Proteus	20,000	14	Newport News Shipb'g Co.	72.0	80.4
Nereus	20,000	14	Newport News Shipb'g Co.	62.5	72.1
Jason	20,000	14	Maryland Steel Co.	66.7	87.2
Jupiter	20,000	14	Navy Yard, Mare Island	85.6	92.5

Recent Developments in Oil Fuel Burning*

BY E. H. PEABODY

Flat Spray Atomizers

Mention has already been made of the special advantages of this device, and the many forms of successful steam atomizers which give a flat flame warrant the belief that there is a wide field awaiting a thoroughly satisfactory flat spray mechanical atomizer.

I have referred to a flat flame atomizer formed of two flat surfaces pressed together, and another consisting of two round oil jets striking together. Neither of these schemes seemed to promise very much in the way of material for development. Another form which does seem to possess some merit, however, is illustrated in Fig. 16. This consists of a means for giving the oil a rapid whirling motion as in the case of the round flame burner and then releasing the liquid through a slot in the side of the tip in a plane at right angles with the axis of revolution instead of through an orifice concentric with the axis. It is apparent that centrifugal force will here come into action as an atomizing agent, but that the spray will be flat instead of conical. So far as I know, the only flat flame mechanical atomizer which has been put on the market is that brought out by the Schutte-Koerting Company, and installed by them on the U. S. S. *Utah*. This burner is simplicity itself—a very considerable advantage—and the spray is excellent at low powers. About the only limitation which I have been able to discover in this burner is the fact that at anything over about 100 pounds of oil delivered per hour the spray loses its finely diffused character. The above installation was made under the direction of Mr. Luther D. Lovekin, a member of this society, whose various successes in burning oil fuel are too well known to require any mention here. I feel sure that if Mr. Lovekin would give his attention to this attractive little flat flame atomizer he would be able to make it a real factor in the art.

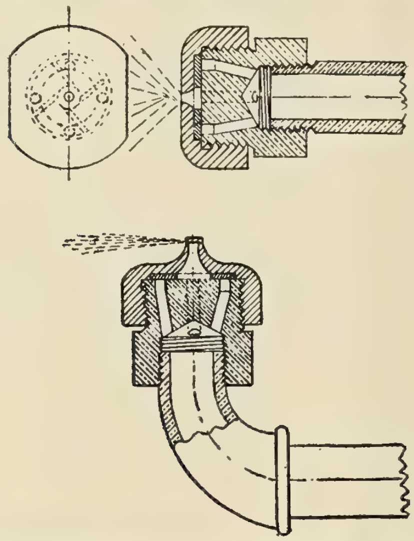


FIG. 16.—PEABODY FLAT SPRAY MECHANICAL ATOMIZER

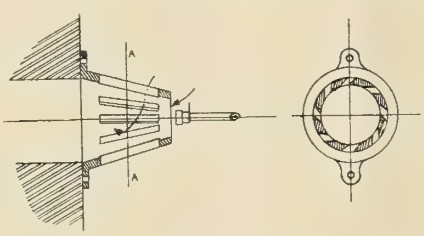
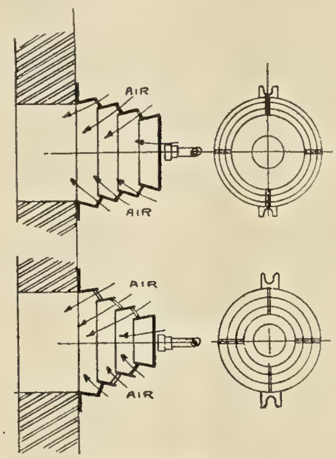


FIG. 17

Air Distributors

While I have indicated some of the various air-distributing devices used in the experiments above described, it seems advisable to group these together with illustrations of some of the principal types which have been tried out. Great delicacy is required in introducing the air for combustion, very slight changes affecting the results in unsuspected ways, and while almost any method may result in smokeless combustion, maximum economy and capacity can only be secured by careful and intelligent design. It is not necessary to give the air a whirling motion, but, judging from our rather exhaustive experiments, better gas analyses are secured, lower air pressures are required, and less refinement of adjustment is needed if the air is brought into contact with the oil spray with the right sort of a twist. We have found the impeller plate illustrated in Fig. 12 most effective in accomplishing this mixture, and our most satisfactory results have been obtained with it.



FIGS. 18 AND 19

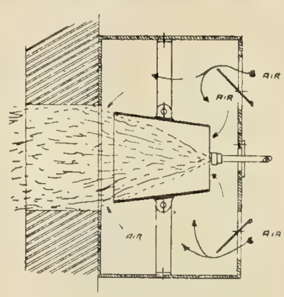


FIG. 20

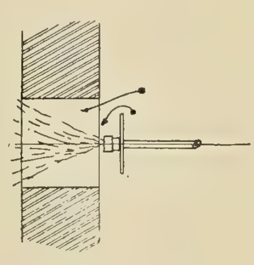


FIG. 21

We have, however, experimented with the following forms, some of which will be familiar to you:

Fig. 17. Cast iron truncated cone, with slots cored in the side so arranged as to give the air a whirling motion. It was tried with the end closed and all the air passing through the slots, and also with the end open, some of the air passing through the slots and some through the end of the cone around the burner. The burner was located at the end of

* Concluded from the February issue.

the cone as shown in the cut, and also pushed into the inner end of the cone, and also in intermediate positions. The whirling motion of the air obtained with this arrangement is of a different character from that obtained with the impeller plate.

Figs. 18 and 19. Truncated cones made up of concentric

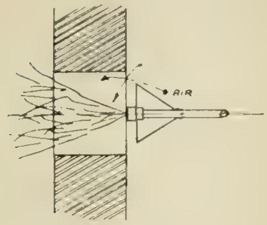


FIG. 22

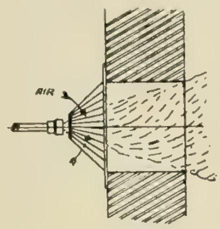


FIG. 23

rings of sheet iron, with air passages between them, and so formed as to direct the air toward the axis. The angle of the first set of rings was 7½ degrees, and that of the second set 15 degrees from the axis. No whirling motion.

Fig. 20. Truncated cone of sheet iron, no air openings in the side but air admitted at both ends, as shown by the arrows in the illustration. No whirling motion.

Fig. 21. Flat disk or plate of sheet iron placed on fire room side of burner tip to produce effect of directing the air to the

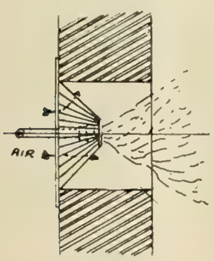


FIG. 24

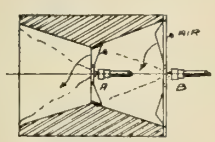


FIG. 25

oil spray, as shown by the arrows. Plate tried in various positions, also removed entirely. No whirling motion.

Fig. 22. Sheet iron cone placed over burner tip to direct air to spray as shown. Tried in various combinations with regard to burner tip and opening to furnace. No whirling motion.

Fig. 23. Conical bladed air impeller, air given a whirling motion and directed in toward axis.

Fig. 24. Conical bladed air impeller, air given a whirling motion but directed away from axis; reverse of last figure.

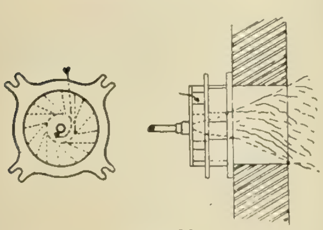


FIG. 26.

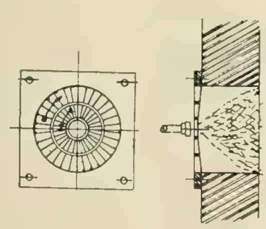


FIG. 27

Fig. 25. Venturi tube effect; air given a whirling motion by means of flat-bladed air impeller. Large impeller set at large diameter at entrance of tube, and also in another experiment small impeller set at contracted diameter of tube.

Fig. 26. Device for giving the air a whirling motion by delivering it in a plane at right angles to the axis of the burner, tangentially to an air chamber surrounding the burner tip. In this arrangement the air was given a whirling motion in a manner very similar to that by which the oil was given a whirling motion inside the burner.

Fig. 27. Flat-bladed air impeller giving the air a double twist, the outer blades driving it one way and the inner blades driving it the other. Also tried three sets of blades, the inner and outer sets driving the air in one direction and the middle set twisting it the other.

Fig. 28. Long horizontal slot admitting the air into a cham-

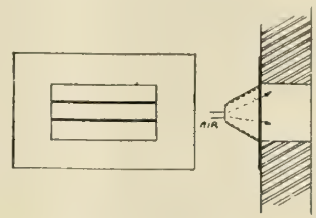


FIG. 28

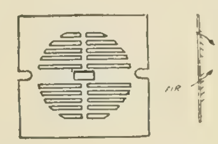


FIG. 29

ber enlarging toward the furnace; used in connection with the flat spray atomizer.

Fig. 29. Series of horizontal blades located on a flat plate over an area of circular form, the blades below the center driving the air upward and the blades above the center driving the air downward; used with flat spray burner.

Fig. 30. Series of vertical blades on a flat plate of oblong shape, the blades below the center driving the air to the left

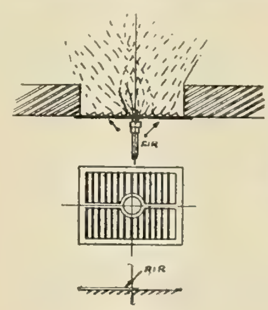


FIG. 30

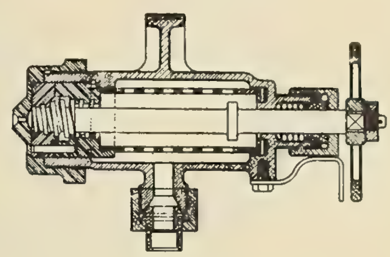


FIG. 31

and the blades above the center driving the air to the right; used with flat spray burner.

PRINCIPAL SYSTEMS USED

This review of the subject of mechanical atomization of oil would not be complete without some reference to the principal systems which have been installed in our torpedo-boat destroyers, and through the courtesy of the editor of the *Journal of the American Society of Naval Engineers* I am able to

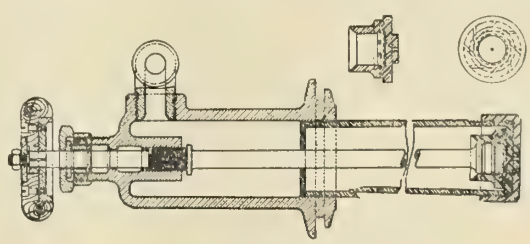


FIG. 32

reproduce illustrations of this apparatus which have been published in that periodical. I also extend my thanks to Mr. John Platt, consulting engineer; Mr. Chas. P. Wetherbee, vice-president of the Bath Iron Works; Mr. H. Brown, assistant to the president of the Fore River Shipbuilding Company; and the Schutte-Koerting Company for information relative to the apparatus in which they are interested.

Thornycroft (Fig. 31).—In this burner the oil receives a whirling motion by passing through a spiral groove into a central chamber communicating with the outlet orifice of the tip. The tip fits on to a nozzle in which there is a cylindrical hole about the same diameter as the central chamber, and concentric with the axis of the burner. In the surface of this cylindrical hole a thread of square section is cut, of very slight depth at the end, coinciding with the central chamber in the tip, but increasing rapidly in depth toward the direction of the opposite end of the burner, at which the oil is admitted. A spindle fits into the cylindrical hole of the nozzle, and on this spindle there is a corresponding thread, accurately fitting the thread of the nozzle and tapering to practically nothing at the end. When the spindle is screwed home the thread on

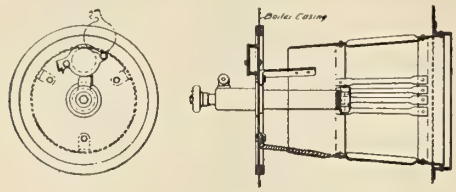


FIG. 33

the spindle bottoms on the tapered thread of the nozzle, and no oil can get to the tip. As the spindle begins to be unscrewed, however, the marked taper of the two threads causes them to separate and form in combination a spiral groove, the sectional area of which rapidly increases as the spindle continues to be unscrewed. The central chamber is formed by the combination of the end of the spindle and the burner tip. The output of this burner is controlled by the revolution of the spindle which regulates the area of the spiral oil passage.

The air for combustion is admitted through annular openings formed between concentric rings or short cylinders

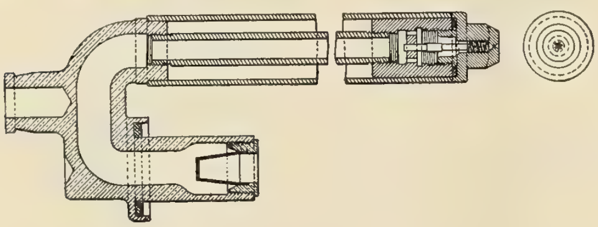


FIG. 34

strung together to form a sort of truncated cone, somewhat similar to the device shown in Figs. 18 and 19, except that the air is not directed toward the center.

Normand (Fig. 32).—Eight small ducts deliver the oil tangentially to the central chamber formed by the combination of the tip and an adjustable spindle. The chamber is recessed so that the movement of the spindle does not in any way close or affect the ducts, its office being, besides forming one wall of the chamber, to close or throttle the outlet orifice. In this burner the ducts and outlet passage and orifice are made in a single piece, which is held to the pipe or body of the burner by a clamp.

The air-distributing device or tuyere consists of a truncated cone of sheet iron fitted on a portion of its surface with blades for giving the air a whirling motion. (Fig. 33.)

Schutte-Koerting (Fig. 34).—The tip of this burner is chamfered out to receive a small spindle, less in diameter than the chamber except at the end, which is provided with a triple parallel thread which just fits the chamber and forms with the surface of the chamber three helical passages which deliver the oil to a smaller chamber at the end of the spindle, communicating with the outlet orifice. The spindle is not adjustable, the burner capacity being varied entirely by controlling the oil pressure and temperature. This burner is fitted with a yoke and hand screw which holds it in position and provides a ready means for disconnecting.

The air distributor is a truncated cone provided with longitudinal slots or openings which may be varied in area by means of a cover or register revolving on the outside and regulated by suitable mechanism. The air does not receive a whirling motion, the mixture with the oil spray being obtained by carrying a high air pressure and forcing it through the restricted area of the slots at high velocity.

Fore River (Fig. 35).—An adjustable spindle in this burner is arranged to throttle or close the outlet orifice and to vary the size of the central chamber to which the oil is delivered

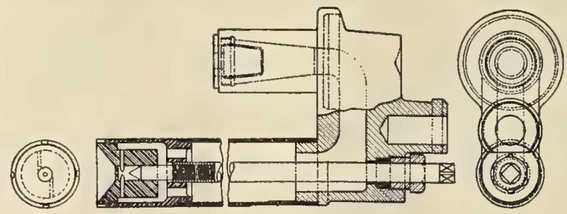


FIG. 35

through two tangential ducts, and the burner is provided with a quick detachable arrangement for holding in place.

The air distributor is a cone provided with air slots in the side which give the air a whirling motion, the area of these slots being controlled by regulating mechanism. The angle of the cone is about 60 degrees, which is much greater than that of any of the designs above described, and another difference lies in the fact that all the air enters through the slots and none around the burner. The slots, besides being so arranged as to give the air a whirling motion, are greater in area in the direction of the furnace.

Conclusion

In the preceding pages I have tried to show that while the problem of oil burning presents some difficulties, particularly as regards admission of air, there is very far from being any mystery about the matter. A strong leaning toward simplicity, "horse sense," and some experience, are a combination reasonably sure of giving good results, and I am not one of those who believe in very much abstruse reasoning or higher mathematics as a necessity. On the other hand, oil is not water, and the manufacturers of water sprinklers who have recently, under the stimulus of the times, entered the field of oil burning and steam generation, will find something more required than a table of steam properties and a few analyses of oil, and will certainly learn the fallacy of the theory that "It's all in the nozzle"—and a poor one at that.

Improvements will be required and will be forthcoming, particularly in connection with spraying the heavier oils, and I look to the flat spray atomizer as a promising field for development. Meanwhile the results already attained are certainly encouraging.

In closing I want to say one word of appreciation of the work of my associate, Mr. David J. Irish, who made so many of the tests referred to above. It was through his ingenuity and originality that our flat impeller plate was developed, and his enthusiasm and industry in carrying out the long and arduous series of experiments undertaken by the Babcock & Wilcox Company were a most important factor in the success of the work.

Ice-Breaking Car Ferry.—An ice-breaking car ferry to connect Prince Edward Island with the mainland is to be built by the Canadian Government at an early date. This vessel is being provided to overcome the slow and costly process of transshipping freight from the island railway to a steamer and again from the steamer to the railway of the mainland.

Lloyd's Summary of World's Shipbuilding

Lloyd's Register of British and Foreign Shipping has recently published its annual summary of shipbuilding throughout the world. This summary includes particulars of vessels of 100 tons gross and upwards, and takes into account only vessels that were launched in 1912, whether they were completed during the year or are still under construction. For this reason Lloyd's returns differ somewhat from those compiled from outside sources, where generally only those vessels completed during the year are considered and the smaller craft are included.

According to Lloyd's summary the total output of the world during 1912, exclusive of warships, appears to have been 2,901,769 tons (2,795,868 steam, 105,901 sail). This is an increase of about 252,000 tons over the figures for 1911. According to the latest information received by Lloyd's Register, the gross tonnage of vessels of all nationalities totally lost, broken up, etc., during the twelve months amounts to about 694,000 tons gross (520,000 steam, 174,000 sail). The net increase of the world's mercantile tonnage at the end of 1912 is thus about 2,208,000 tons. Steam tonnage has been increased by about 2,276,000 tons, while sailing tonnage has been reduced by 68,000 tons.

The warship tonnage launched in the world during 1912 amounts to about 535,000 tons displacement. This total, although 234,240 tons less than the huge output for 1911, exceeds the average annual tonnage launched during the nineteen years 1892-1910 by about 217,000 tons. Excluding one battleship intended for the Spanish navy, the average displacement of the battleships and cruisers launched during 1912 is no less than 24,645 tons.

Shipbuilding in the United Kingdom

Particulars of Total Output.—During 1912, exclusive of warships, 712 vessels of 1,738,514 tons gross (viz., 643 steamers of 1,720,957 tons and 69 sailing vessels of 17,557 tons) have been launched in the United Kingdom. The sailing ship tonnage is composed, however, almost entirely of barges and similar craft. The warships launched at both Government and private yards amount to 30 of 191,737 tons displacement. The total output of the United Kingdom for the year has, therefore, been 742 vessels of 1,930,251 tons. In these notes, warships are excluded from consideration except where they are specially mentioned.

The output of mercantile tonnage in the United Kingdom during 1912 shows a decrease of 65,330 tons on that of last year. As regards war vessels the total is 39,049 tons less than in 1911.

Practically the whole of the tonnage launched has been built of steel, and nearly 99 percent is composed of steam tonnage.

Comparison of Tonnage Afloat, 1911-1912.—Of the total output, over 76 percent, or 1,322,995 tons (1,313,683 steam tons and 9,312 sailing tons), has been built for registration in the United Kingdom.

In this connection it should be noted that, from the information at present in the possession of Lloyd's Register, the gross tonnage of United Kingdom vessels lost, broken up, etc., during the last twelve months appears to have been 308,000 tons (286,000 steam, 22,000 sail), while the sales to foreign and colonial owners have reached the record total of 704,113 tons (649,368 steam, 54,745 sail). On the other hand, 6,144 tons (5,196 steam, 948 sail) were built abroad for United Kingdom owners, and purchases from foreign and colonial owners during the same period amounted to 37,877 tons (36,462 steam, 1,415 sail).

The steam tonnage of the United Kingdom would thus appear to have increased by about 420,000 tons, and the sailing tonnage to have decreased by about 65,000 tons. The net increase of United Kingdom tonnage at the end of 1912 is therefore about 355,000 tons.

From the annual statements of the navigation and shipping of the United Kingdom, issued by the Board of Trade, showing the number and tonnage of vessels on the Register at the end of each year, which statements, however, take into account vessels of less than 100 tons, it appears that the net increases in the United Kingdom tonnage for the previous five years were as follows: 1907, 630,706 tons; 1908, 161,873 tons; 1909, 150,686 tons; 1910, 66,694 tons; 1911, 339,564 tons.

Vessels Launched for Abroad.—The amount of tonnage launched for abroad during 1912 was 415,519 tons, forming 23.9 percent of the total output, as compared with 22⅓ percent in 1911, 19½ percent in 1910, 24 2/5 percent in 1909, 40 percent in 1908, 34 percent in 1907, 20⅓ percent in 1906, 21½ percent in 1905, and 18⅔ percent in 1904. The British Colonies have provided the largest amount of work for the shipbuilders of the United Kingdom, viz.: 47 vessels of 72,970 tons (nearly 4 1/5 percent of the total output). Norway occupies the second position with 69,006 tons, being followed by Germany with 43,154 tons, Holland with 40,678 tons, Spain with 31,320 tons, and Austria-Hungary with 27,962 tons.

Size and Speed of Vessels.—The number of large steamers launched in the United Kingdom during 1912 has greatly exceeded the average of recent years. During the year 1892-96, 47 vessels of 6,000 tons and upwards were launched in the United Kingdom; in the following five years, 1897-01, the number rose to 166; in the next five years, 1902-06, 156 were launched, and during the five years, 1907-11, 167 such vessels were launched. Of vessels of 10,000 tons and upwards, only five were launched in the five years 1892-96, 32 were launched during the five years 1897-01, 29 were launched during the five years 1902-06 and 48 during the five years 1907-11.

The returns for 1912 show that 69 vessels of 6,000 tons and above were launched. Of these, 16 were over 10,000 tons each, the largest being the White Star steamship *Ceramic,* of 18,600 tons, and the Canadian Pacific steamers *Empress of Asia* and *Empress of Russia,* 16,850 tons each. The following are the other vessels of 11,000 tons and upwards, viz.:

	Tons gross
Nestor	14,200
Niagara	13,500
Darro	11,484
Desna	11,483
Drina	11,240
Beltana	11,120
Benalla	11,120
Kristianiafjord	11,000

The average tonnage of steamers launched in the United Kingdom during 1912 is 2,676 tons; but if steamers of less than 500 tons be excluded the average of the remaining steamers reaches 3,955 tons gross, which is a considerable advance on the mean of the averages of the previous five years.

Of the vessels launched in the United Kingdom 24 are capable of a speed of 16 knots and above. The fastest of these are the turbine vessels *Empress of Asia, Empress of Russia* and *Wahine,* two other turbine steamers intended for service on the Irish Channel and one for service on the Clyde, all designed for a speed of 20 knots.

Vessels Fitted with Turbines and Internal Combustion Engines.—Four steamships, viz.: *Ceramic, Niagara, Reina Victoria Eugenia* and *Infanta Isabel de Borbon,* with a total tonnage of 51,890 tons, are being fitted with a combination of turbines and reciprocating engines. During 1912, including vessels mentioned in the preceding paragraph, 8 steamers were launched with a total tonnage of 42,261 tons which will have turbines only.

The launches for the year also include 11 vessels of a total tonnage of 6,000 tons with internal combustion engines, the largest being the *Fordonian,* of about 2,000 tons. These figures include the *Y. Ddraig Gôch,* of about 1,000 tons fitted with gas engines.

Other Special Types.—Of steamers building on the Isherwood system of longitudinal framing, 31 were launched during 1912, with a gross total tonnage of 153,702 tons. Including 6 of these vessels with a tonnage of 24,856 tons, there were launched during the past year 18 steamers of 90,222 tons for the carriage of oil in bulk. The returns also include 7 vessels of other special constructional design; 127 steam trawlers, whalers, and other fishing vessels; 83 dredgers and barges; 24 tugs, 5 yachts, besides a number of other vessels designed for channel, river and other special services.

Output of Leading Ports.—The Glasgow district occupies the first place among the shipbuilding centers of the country, showing an output of 338,954 tons. Then follow Newcastle with 317,654 tons, Sunderland with 305,734 tons, Greenock with 237,393 tons, Belfast with 161,261 tons, Middlesbro' with 143,570 tons, and Hartlepool with 121,725 tons. In warship tonnage Newcastle leads with 31,520 tons displacement, followed by Barrow with 30,120 tons and Liverpool with 28,400 tons.

Progress of Shipbuilding During the Year.—As regards the movement of the shipbuilding industry during the course of 1912, Lloyd's Register Returns show that, at the opening of the year, irrespective of warships, 1,519,052 tons were being built in the United Kingdom. The returns for the March quarter indicated an increase of about 168,000 tons in the work in hand; the June and September returns showed a further increase of about 87,000 tons, and 73,000 tons respectively. The amount of tonnage under construction at the end of December, which was 1,970,065 tons, is greater than any ever reached before and exceeds by 451,000 tons the amount at which it stood at the end of 1911. The total warship tonnage under construction in the country is now 496,875 tons displacement as compared with 408,755 tons twelve months ago.

Work in Hand at the End of 1912.—At the end of December there were under construction, including a number of vessels already launched but not completed, 69 vessels of between 6,000 and 10,000 tons, 25 of between 10,000 and 15,000 tons, 10 of between 15,000 and 20,000 tons, 2 of between 20,000 and 40,000 tons, and 2 of over 40,000 tons each.

Many of these are of special interest, among which are the following, not already named in the foregoing notes:

(*a*) The Cunard steamship *Aquitania,* of 45,000 tons; two Allan liners, of 16,000 tons each, and four other steamers of a total tonnage of 4,150 tons, all to be fitted with steam turbines.

(*b*) Nine steamers, with a total gross tonnage of 194,380

TABLE 1.—SUMMARY OF THE WORLD'S SHIPBUILDING OUTPUT FOR THE YEARS 1910, 1911 AND 1912

Where Built.	Description.	1910. No.	1910. Tonnage.	1911. No.	1911. Tonnage.	1912. No.	1912. Tonnage.
United Kingdom	Merchant vessels	500	1,143,169	772	1,803,844	712	1,738,514
	Warships	45	134,645	50	230,786	30	191,737
	Total	545	1,277,814	822	2,034,630	742	1,930,251
Abroad	Merchant vessels	777	814,684	827	846,296	1,007	1,163,255
	Warships	77	176,209	119	538,083	144	342,892
	Total	854	990,893	946	1,384,379	1,151	1,506,147
	World's output	1,399	2,268,707	1,768	3,419,009	1,893	3,436,398

TABLE 2.—TABLE SHOWING THE TONNAGE OF VESSELS OF 100 TONS GROSS AND UPWARDS (EXCLUDING WARSHIPS) LAUNCHED IN THE UNITED KINGDOM AND ABROAD DURING THE LAST DECADE

Year.	United Kingdom. Tons.	British Colonies. Tons.	Austria-Hungary Tons.	Denmark. Tons.	France. Tons.	Germany. Tons.	Holland. Tons.	Italy. Tons.	Japan. Tons.	Norway. Tons.	United States. Tons.	Other Countries. Tons.	Totals. No.	Totals. Tons.
1903	1,190,618	34,690	11,328	28,609	92,768	184,494	59,174	50,089	34,514	41,599	381,820	35,928	1,650	2,145,631
1904	1,205,162	30,965	16,645	15,859	81,245	202,197	55,636	30,016	32,969	50,469	238,518	28,254	1,643	1,987,935
1905	1,623,168	10,798	16,402	17,557	73,124	255,423	44,135	61,629	31,725	52,580	302,827	25,554	1,576	2,514,922
1906	1,828,343	26,042	18,590	24,712	35,214	318,230	66,809	30,560	42,489	60,774	441,087	26,913	1,836	2,919,763
1907	1,607,890	46,443	8,717	28,819	61,635	275,003	68,623	44,666	66,254	57,556	474,675	37,807	1,788	2,778,088
1908	929,669	34,181	23,502	19,172	83,429	207,777	58,604	26,864	59,725	52,839	304,543	32,981	1,405	1,833,286
1909	991,066	7,461	25,006	7,508	42,197	128,696	59,106	31,217	52,319	28,601	209,604	19,276	1,063	1,602,057
1910	1,143,169	26,343	14,304	12,154	80,751	159,303	70,945	23,019	30,215	36,931	331,318	29,401	1,277	1,957,853
1911	1,803,844	19,662	37,836	18,689	125,472	255,532	93,050	17,401	44,359	35,435	171,569	27,291	1,599	2,650,140
1912	1,738,514	34,790	38,821	26,103	110,734	375,317	99,439	25,196	57,755	50,255	284,223	60,622	1,719	2,901,769

TABLE 3.—TABLE SHOWING THE NUMBER AND DISPLACEMENT OF WARSHIPS OF 100 TONS AND UPWARDS LAUNCHED FOR THE VARIOUS NAVIES DURING THE LAST DECADE

Year.	British. No.	British. Tons.	United States. No.	United States. Tons.	Austro-Hungarian. No.	Austro-Hungarian. Tons.	French. No.	French. Tons.	German. No.	German. Tons.	Italian. No.	Italian. Tons.	Japanese. No.	Japanese. Tons.	Russian. No.	Russian. Tons.	Other Flags. No.	Other Flags. Tons.	Total. No.	Total. Tons.
1903	38	147,813	13	66,140	2	17,520	15	30,760	16	60,590	..	......	17	13,917	9	38,430	9	15,930	119	391,100
1904	33	126,375	14	170,185	3	11,480	9	43,600	11	44,970	4	25,932	4	608	5	1,750	19	10,106	102	435,006
1905	23	96,505	7	98,200	3	11,020	7	28,611	6	36,487	10	14,490	17	50,633	37	15,721	8	11,544	118	363,211
1906	23	85,700	5	45,443	10	2,760	6	15,183	17	62,678	14	3,039	24	41,277	19	82,204	30	24,688	148	362,972
1907	33	133,405	5	11,590	7	1,594	17	33,594	17	14,800	12	25,154	10	57,200	17	35,317	24	8,557	142	321,211
1908	26	49,560	8	52,850	8	16,153	22	21,600	16	97,660	5	29,400	4	2,245	11	8,800	27	31,421	127	309,689
1909	35	98,790	15	48,639	23	22,217	19	95,740	27	99,116	8	2,088	1	375	2	1,246	21	36,264	151	404,475
1910	43	133,525	13	30,287	8	14,993	12	24,063	21	49,024	4	19,374	3	23,100	..	......	18	16,488	122	310,854
1911	41	221,430	13	57,526	2	20,269	15	53,995	28	128,340	15	75,018	6	37,071	5	93,260	44	81,960	169	768,869
1912	28	163,087	15	62,673	7	49,361	21	55,965	30	99,810	35	14,939	4	56,035	1	492	33	32,267	174	534,629

tons, which will all be fitted with a combination of steam turbines and reciprocating engines, viz.: *Britannic,* 50,000 tons, White Star Line; one, 32,500 tons, Holland-Amerika Line; one, 27,000 tons, Red Star Line; two, 29,900 tons, Royal Mail S. P. Co.; two, 31,200 tons, Pacific Stm. Nav. Co.; one, 14,980 tons, Geo. Thompson & Co.; one, 8,800 tons, McIlwraith, McEacharn & Co.

(*c*) Two vessels of between 3,000 and 4,000 tons each, besides a number of small craft, for which the propelling power will be internal combustion engines.

(*d*) Forty steamers to carry oil in bulk with a total tonnage of about 231,000 tons.

(*e*) Forty-six steamers of about 267,000 tons which are building on the Isherwood longitudinal framing system. Thirty-one of these vessels, of about 194,000 tons, are oil-carrying vessels, and are included in the figures given in paragraph (*d*).

SHIPBUILDING IN FOREIGN COUNTRIES

Particulars of Total Output.—There have been launched abroad, during the year, 1,007 vessels of 1,163,255 tons (720 steamers of 1,074,911 tons and 287 sailing vessels of 88,344 tons). These figures show the very large increase of about 317,000 tons as compared with those for 1911. Among foreign countries, the leading places are held by Germany with 375,317 tons, the United States with 284,223 tons, France with 110,734 tons, Holland with 99,439 tons, Japan with 57,755 tons and Norway with 50,255 tons.

The returns for the year include 36 vessels of between 4,000 and 6,000 tons; 27 of between 6,000 and 8,000 tons; 9 of between 8,000 and 10,000 tons; and the fast turbine steamer *Imperator,* of about 52,000 tons, launched in Germany. In addition, 4 colliers of about 10,000 tons each were launched for the United States Navy. During 1912 seven vessels of over 3,000 tons each, to be fitted with internal combustion engines, were launched abroad. Their aggregate tonnage amounted to about 30,000 tons. Two other vessels of over 1,000 tons each, and a large number of vessels of small tonnage similarly fitted were also launched. The output abroad for the year also includes 10 oil-carrying steamers of a total tonnage of 44,154 tons.

The total output of war vessels abroad, which comprised 144 vessels of 342,892 tons displacement, shows the large decrease of over 195,000 tons displacement as compared with the figures for the preceding year.

Germany.—The returns show an increase of nearly 120,000 tons in the shipbuilding output as compared with last year, and the figures (375,317 tons) are about 57,000 tons higher than the total built in 1906, which was the previous highest on record. As usual, the figures do not take into account a large number of river craft launched at yards situated on the upper rivers.

Twenty-eight steamers of 5,000 tons and under 10,000 tons were launched in the country during 1912. In addition there was launched at Hamburg the Hamburg-American liner *Imperator,* of about 52,000 tons gross, the largest vessel up to date.

The total output includes five vessels of 18,258 tons fitted with internal combustion engines, the largest being the oil-carrier *Hagen,* 5,810 tons, and 10 other vessels with similar engines, of an average tonnage of 271 tons.

There were under construction at the end of December, one turbine steamer of about 58,000 tons, one steamer of about 35,000 tons, three of between 20,000 and 25,000 tons (one of them to be fitted with turbines), two of between 10,000 and 15,000 tons, and thirty other vessels of between 5,000 and 10,000 tons each, including eleven built to carry oil in bulk, three of which will be fitted with internal combustion engines.

United States.—The tonnage reported from the United States, which amounts to 284,223 tons, is over 112,000 tons higher than that of the previous year. The bulk of this increase is due to the greater activity of the shipyards on the coast. The tonnage launched on the Great Lakes amounts to nearly 90,000 tons, and includes six vessels of over 5,000 tons, the largest being of about 8,600 tons. On the coast there were only launched four sea-going merchant steamers of between 5,000 and 7,000 tons each, and four naval colliers of about 10,000 tons, one of which, the *Jupiter,* is to be driven by electric motors worked by an alternator connected to steam turbines. Besides the above vessels there were building at the end of 1912 eleven merchant steamers of between 5,000 and 9,000 tons each.

France.—The present returns, 110,734 tons, show a decrease of nearly 15,000 tons as compared with the tonnage launched during 1911. The figures include six steamers of over 5,000 tons, the largest being the *Mississippi,* of about 7,000 tons; also the turbine channel steamer *Rouen,* 1,656 tons, designed for a speed of 22 knots. The work in hand at present amounts to over 175,000 tons. This total comprises ten steamers of from 5,000 to 9,000 tons, and four of between 12,000 and 15,000 tons, two of which will be fitted with a combination of turbines and reciprocating engines.

Holland.—The total tonnage, aggregating 99,439 tons, launched in Holland during the past year exceeds by over 6,000 tons the figures for 1911, and are the highest ever recorded in the Society's Returns for that country. This total does not include vessels known to be exclusively intended for river navigation. From the returns received it appears that the tonnage of steamboats, barges, and other river vessels launched during 1912 amounts to more than 90,000 tons.

The largest vessels launched were three of between 6,000 and 7,000 tons each. The output also includes two vessels of a combined tonnage of 7,157 tons and seventeen small vessels, none of which exceeds 350 tons, all to be fitted with internal combustion engines.

There are now building five other steamers of between 7,000 and 9,000 tons. Two large cargo steamers, 4,500 tons each, are also in hand to be fitted with oil engines.

Japan.—The tonnage launched during the year, amounting to 57,755 tons, shows a fairly large increase on the output of 1911. It is, however, mostly composed of small vessels, with the exception of two steamers of about 6,500 tons each.

Austria-Hungary.—The returns show a very slight increase in the output of this country. The present figures, 38,821 tons, however, are composed almost entirely of vessels of between 5,000 and 8,000 tons. At the end of 1912, there were under construction, but not yet launched, over 57,000 tons of new vessels, including one of nearly 15,000 tons.

Norway.—The output for the year amounts to 50,255 tons, which is nearly 15,000 tons more than that of 1911. There is no special feature of interest in the returns, which, as in recent years, comprise a very large number of small vessels. Only eight steamers of between 1,500 and 1,800 tons were launched.

Other Countries.—The output of the British Colonies, amounting to 34,790 tons, is 15,000 tons more than that for 1911. Only a very small part of the increase, however, consists of sea-going tonnage.

Denmark, with 26,103 tons, shows an increase of over 7,000 tons on the total for 1911. Included in this total are two vessels of 4,934 tons and 3,716 tons, fitted with Diesel engines. This method of propulsion is being adopted in the cases of several cargo vessels of considerable size building in this country.

The figures for Italy, 25,196 tons, are 8,000 tons more than those of 1911. It may be mentioned that the total tonnage now building, 52,370 tons, is over 33,000 tons higher than that in hand at the end of 1911.

Work in Hand at the End of 1912.—At the end of December there were under construction abroad 1,368,671 tons gross

(1,337,078 tons steam and 31,593 tons sail). Germany occupies the first position with 542,519 tons, and next come the United States with 236,185 tons, France with 175,588 tons, and Holland with 114,811 tons. These figures are exclusive of vessels for service on inland rivers. Of vessels the construction of which had been actually commenced but which were not yet launched, there were seventy-three steamers of between 5,000 and 10,000 tons, thirty of which are building in Germany; seven steamers of between 10,000 and 15,000 tons, and five steamers of over 20,000 tons, all in Germany, the largest being of about 58,000 tons and 35,000 tons, respectively. These figures include three vessels aggregating 96,000 tons, to be fitted with turbines, three of 39,000 tons with a combination of turbines and reciprocating engines, and six of 33,000 tons to be fitted with internal combustion engines. There are also four other vessels building on the Continent of between 3,000 and 5,000 tons each, to be fitted with this latter type of engine.

Comparison of Output in the United Kingdom and Abroad

The returns under review show that although the activity which has characterized the shipbuilding industry in the United Kingdom throughout the year 1912 has never been equaled before, the amount of tonnage actually *launched* during the twelve months for various reasons fell below the total output of 1911 by some 65,000 tons.

Foreign shipyards, however, have achieved a record output during 1912, having launched no less than 317,000 tons of merchant vessels in excess of the tonnage put into the water during 1911.

The highest foreign individual increases for the year are: United States, 66 percent; Germany, 50 percent, and Italy, 45 percent.

Of the tonnage launched in the world during 1912, the United Kingdom has acquired 45.8 percent, while 60 percent was launched in the United Kingdom. If, however, only *sea-going merchant steamers* of 3,000 tons gross and upwards be taken into account, out of the total of 367 such steamers, of 2,019,763 tons, launched in the world, 71.3 percent of the tonnage has been launched in the United Kingdom.

Subsidies Aid Swedish Shipping

To afford direct communication with distant ports and to encourage commerce, and especially the export trade, the Swedish Government has within the last few years instituted a system of subsidies in aid of privately owned Swedish steamship companies. These subsidies are equivalent to a bounty or premium paid by the government, which, at financial risk and uncertainty as regards the eventual success of the proposed lines, has undertaken the building of the ships necessary to maintain such frequent communication as will answer to the commercial and industrial requirements of the country.

These subsidies are entirely apart from the so-called "State contributions," which provide for loans to shipowners from government funds. To show the extent with which at present the distant port foreign commerce is carried on from Sweden, names of companies, countries traded with, and other particulars are herewith given.

The Swedish Asiatic Company, Ltd., with a capitalization of about $675,000 (£138,500), operating with six steamers between Gothenburg, Sweden, and Port Said, Singapore, Hongkong, Shanghai, Yokohama, Kobe and Moji. These boats are about 9,000 tons carrying capacity, having 2,800 horsepower with a speed of about 11 knots. This company has received subsidies since 1907 at the rate of $81,500 (£16,700) per year; the main offices being situated at Gothenburg under the direction of Mr. Dan. Bostrom, whose companies now control a very large percentage of Sweden's shipping interests.

The Axel Johnson Company, of Stockholm, with a capitalization of about $1,350,000 (£278,000), operates four boats of about 6,600 tons carrying capacity, and in addition is building four more to be equipped with Diesel motors for a speed of 11 knots. This company operates its steamers between Sweden and Argentina and receives subsidies yearly equal to those of the Swedish East Asiatic Company, Ltd.

Transatlanticka Balaget, of Gothenburg, operates six steamers of about 7,500 tons carrying capacity, having a speed of 10 knots, and is capitalized for about $950,000 (£195,000). It keeps up regular communications between Sweden and South Africa and will receive subsidies commencing 1913 amounting to about $42,000 (£8,620) yearly.

Svea Balaget, of Stockholm, capitalized for about $675,000 (£138,500) operates between Sweden and Russia, and receives yearly subsidies of $27,000 (£5,550).

The Melike-Amerika Linen started direct communications between Sweden and Mexico and America recently, with four new boats ranging in size between 6,000 and 7,000 tons carrying capacity. This line is receiving subsidies yearly amounting to $81,000 (£16,600) to run for a period of three years from Jan. 1, 1913.

The principal goods of export from Sweden consist of lumber, both finished and unfinished, granite stones for pavements, paper and pulp from which paper is made, bar iron, pig iron, matches, dairy products, machinery and acids. The imports carried by the steamers engaged in the trades referred to are: Cotton, sugar, beans, tea, grain, coffee, sugar and wool. The foregoing companies are financed principally by Swedish capital, the ships being manned by Swedish officers and crews. The administrations and operations are controlled entirely by the companies from their main offices at Gothenburg and Stockholm.

The enormous increase in the export trade in goods, which formerly was carried on on a small scale only in sailing vessels, is due to the regularity and the greater rapidity with which transportation under reasonable government aid is now carried on. The lessening of cost in transportation due to savings in transshipment plays an important role in enabling Sweden to compete in the world markets with other and more fortunately situated countries. This applies principally to goods produced in the industrial arts.

The following review, giving an average of the items with respect to salaries and subsistence expenditures, and which largely constitute so-called running expenses, is interesting to note:

Salary of captains, yearly	$2,000.00	(£411.00)
Salary of chief officer, monthly	45.00	(9.25)
Salary of second officer, monthly	40.00	(8.21)
Salary of third officer, monthly	33.00	(6.78)
Salary of chief engineer, monthly	81.00	(16.65)
Salary of second engineer, monthly	58.00	(11.70)
Salary of third engineer, monthly	48.00	(9.86)
Salary of fourth engineer, monthly	27.00	(5.54)
Salary of fireman, monthly	17.00	(3.50)
Salary of crew, average, monthly	14.00	(2.88)
Subsistence per man per month	11.50	(2.36)

The subsidies paid by the Swedish Government are purely trade bounties and do not cover any premiums on the construction of vessels, nor are they in the form of naval subventions whereby merchant ships are constructed to conform with certain naval requirements, making them available for naval service.

Unfortunately for Swedish shipbuilding interests no reference is included in the laws governing these trade bounties as to domestically or foreign-built ships.

Strange as it may seem, it is nevertheless a fact that the shipbuilders in Sweden, a country with almost an inexhaustible supply of the raw material from which the best iron and steel in the world may be produced, are not in a position to build steel ships as cheaply as some other European countries, especially England. The reason for this lies, not in the difference in the wage scale, as in the United States, but in the increased cost of the Swedish finished materials, such as plates, bars, and shapes over similar materials produced in the country above mentioned. Therefore, a large number of the ships used in the distant port trade are foreign built.

The principal reason for the enhanced cost in steel produced in Sweden will be found in the almost complete absence of coal in the country, which is essential for the cheap reduction of iron ore. The best Swedish iron is reduced from the ore by using charcoal, a process which is greatly limited.

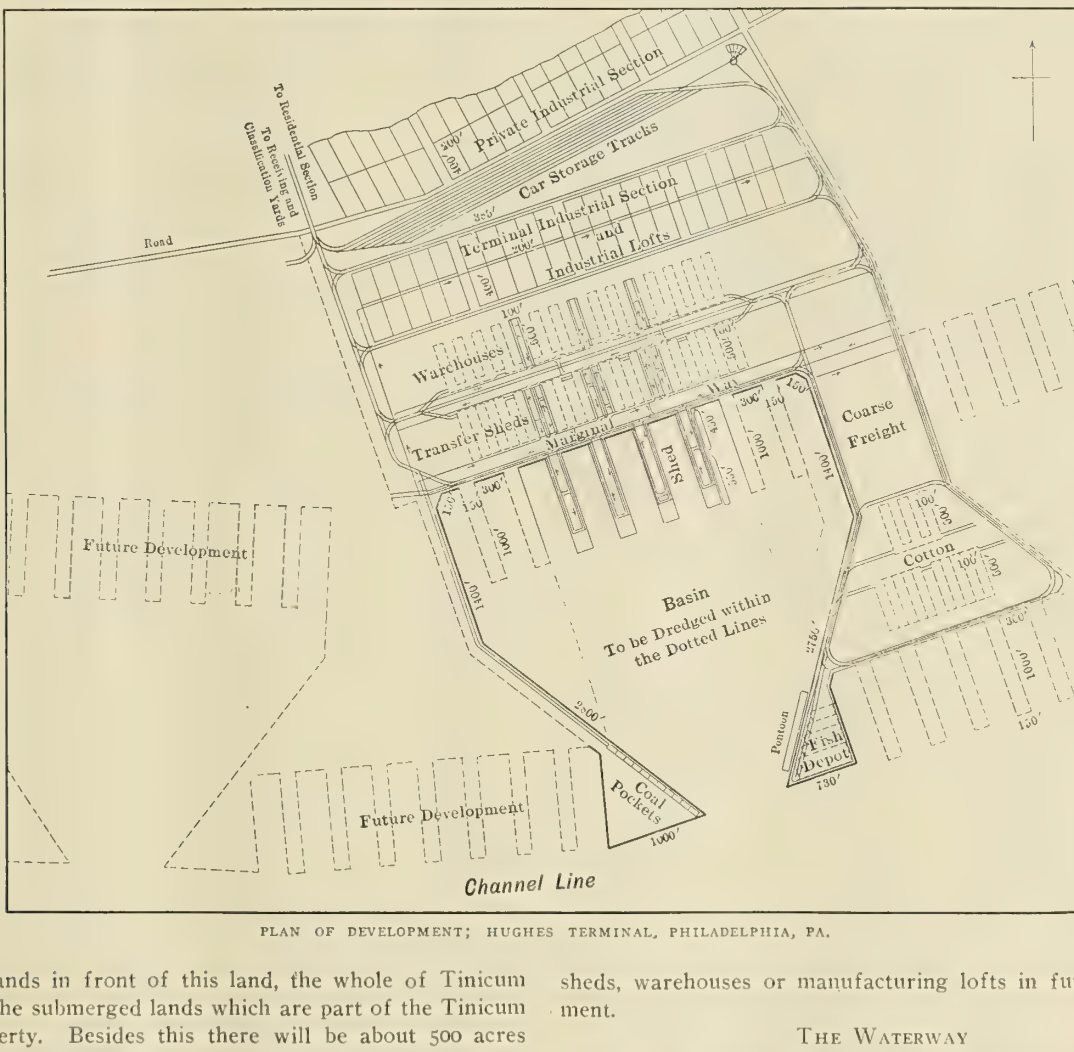
New Steamship Terminal at Philadelphia

BY H. McL. HARDING*

Plans have been made for the establishment of a new steamship terminal, to be known as the Hughes Terminal, at an advantageous point on the Delaware River about eighty miles from the sea and about eight miles from the Philadelphia city hall, contiguous to the boundary line of the city. The site comprises about 2,500 acres between a trolley road which runs parallel with the shore line of the river and the present shore line, the islands in front of this land, the whole of Tinicum Island and the submerged lands which are part of the Tinicum Island property. Besides this there will be about 500 acres beyond the trolley road.

In the first layout as planned, there will be about 20,000 feet of lineal frontage, or berthing capacity at one time for some forty vessels 500 feet in length. There will be two piers, each 1,000 feet in length. There is space for eight 1,000-foot piers within the basin. In future development, each new basin will have practically the same lineal pier and quay length, the three basins therefore having a lineal frontage of 60,000 feet.

There can be five river piers, with 10,000 feet frontage, in front of the cotton area. Other river piers can give 24,000 feet additional. Furthermore, there can be developed a frontage upon both sides of Tinicum Island west of the terminal proper development. It will, therefore, be seen that there will be a surplus of frontage for many years to come. The western end of Tinicum Island will probably be used for transshipment sheds, warehouses or manufacturing lofts in future development.



PLAN OF DEVELOPMENT; HUGHES TERMINAL, PHILADELPHIA, PA.

THE WATERWAY

There is at present a depth of 30 feet in the channel, and an appropriation has been made by the Government to increase this channel to 35 feet in depth and 800 to 1,000 feet in width. The river, opposite the present terminal shore line, to the New Jersey shore is a mile and a quarter wide. It will be noticed that there is not only ample land area, but also water area for all terminal requirements, including not only anchorage, but also ship-turning space. All the basin will not at first be dredged to the depth of 30 feet, but the portion

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between the dotted lines and along the right-hand quay wall. The depth of the rest of the basin will be made sufficient for tugs, barges, lighters and small vessels. The plan of the basin and piers is so designed as to afford easy egress and ingress for steamships.

General Terminal Capacity

It is estimated conservatively, by making use of the latest mechanical appliances, that there should be an annual transferring capacity at the 20,000 lineal feet of pier and quay walls of about 4,000,000 tons.

Delaware River Piers

There will be noticed groups of piers, some within the basins and others along the Delaware River. The basin piers will be first constructed, and later, as required, the river piers. When the river piers are constructed, warehouses can be built within the space now designated as occupied by coarse freight. Other locations can then be set aside for coarse freight or that not affected by the weather. This arrangement of the two sets of piers with the connecting quay walls gives, under the existing physical conditions, the greatest capacity at the least expense.

Divisions for Different Commodities

Provision must be made for the prompt transferring of miscellaneous cargoes with many marks and cross marks; of cargoes of one commodity, such as cotton, but with a number of marks; cargoes of one kind and one mark, such as lumber or logs, and also—that which is of great importance—bulk cargoes of coal, rock, ore and similar material. It is, therefore, advisable that certain locations be designated, and, as far as is practicable, be reserved for these different commodities.

There should also be reserved to a less degree separate berths for foreign and for coastwise ships, and also for the so-called "tramps" and the barges and lighters. A lighter or barge may not require more than 10 or 12 feet draft, and therefore should not occupy berths required for foreign or coastwise freighters drawing over 20 feet.

The Surface Railroad Tracks

It is the purpose to transfer the freight as far as practicable directly to cars upon tracks behind each pier or quay. This may be from the ship's hold, from the ship's deck, or from the pier's side. Proper consideration will be given in this connection to customs regulations, assorting and distributing. In order to do this without rehandling, which would add some 15 to 20 cents (7½d. to 10d.) per ton to the transference cost for miscellaneous freight, it is necessary to have trackage for a sufficient number of cars in connection with each one or two combined sections of the terminal not less than placement for 300 cars, so as to avoid more than one handling.

In the storage yards to the north of the terminal will be trackage for over 900 additional cars, and more trackage in other locations. Trackage is also provided for cars within the sheds and warehouses, between the sheds and warehouses, and between the warehouses and the industrial section, and the number of tracks in the storage yards can be largely increased. Space can readily be reserved still further to the north of and within the terminal grounds for classification and transfer yards. A successful terminal requires ample trackage and car room, as is well known to all transportation managers.

Between each of the four lines of tracks serving the piers and quays are platforms about 20 feet in width. This enables the cars to be loaded and unloaded without the tedious and laborious "spotting." Many sidings will be so arranged, not only for l. c. l. freight, but also for full carloads, and for the local team freight. In this preliminary plan, for the sake of clearness, all of these tracks are not shown. Miscellaneous freight is generally shipped in box cars. Bulk freight and structural steel being often shipped in open cars, should be loaded and unloaded without rehandling. In general, it may be said that the question of ample room for tracks and their locations has received careful study and consideration.

No successful terminal has proved to be too large, and all the available space here will sooner or later be needed. It therefore seemed advisable for the tracks to pass through the lower story of the sheds. Another advantage of this is that the handling and transferring of the freight are done under cover, avoiding horizontal movements, whereby the work can proceed during inclement weather and the property be protected from damage and also from thefts. It is also proposed to extend the sidings through a portion of the lower story of the warehouses for similar reasons, and for the direct elevation of the freight to the upper story or stories; but tracks are not to be extended within the pier sheds or upon the piers, except possibly on special piers for the transference of bulk freight or cargoes of few marks. For miscellaneous or package freight service, it is not advisable that cars should pass upon the piers.

Internal Water Area

The basin, as located, adds to the value of all the other terminal sections. Not only will it be an anchorage place for barges and lighters, but as a temporary mooring place for even the longer vessels. Its quay walls can give berthing space for foreign and domestic steamships, and the quay walls on the right and left of the basin are admirably situated for lighterage service.

One basin slip has been indicated as dredged within the eastern portion of the basin, about 2,600 feet long and 300 feet wide. The reason for this is that it seems to be excellently well adapted for special freight and for transference to the local industries by railway or transfer tracks. As there must be a location where certain classes of cargoes can be transferred directly between ships and lighters, the basin can be used for this purpose.

Although there seems to be an excess of frontage, yet it is recommended that none of the water front, as shown improved, be long-leased or sold for private occupancy. It will all be needed. Furthermore, under long leases, walls and piers are often allowed to deteriorate, and this affects the value and appearance of the whole terminal. It will always be of more value and use if used by the terminal and its tenants under the direction of the Terminal Company. This recommendation does not apply to lands outside the terminal proper. It is preferable to follow the methods of Liverpool and other foreign terminals in this respect.

Marginal Way

A strip of land 200 feet in width, in front of the transfer sheds and called the marginal way, is reserved for the common use of all the factories and the whole terminal and for surface tracks and overhead runways.

Transshipment Sheds

In the basin section these sheds are upon the piers. Only two sheds will be constructed at first. These transshipment pier sheds will be of one story, about 40 feet in height, 138 feet in width and 800 feet long. They will be fully equipped with freight-tiering and transferring machinery. To the east of the basin will be other transit sheds in the future 100 feet wide and 500 feet long, of the two-section type. These are chiefly for the transference and storage of cotton and similar material, which, on account of the fire risk, it is desirable to isolate.

Transfer Sheds

To the rear of the marginal way are the transfer sheds for the transference to or from the cars or drays, and for a shorter time storage than for warehouse storage.

Warehouses

Towards the north of the transfer sheds, between them and the industrial section, will be located warehouses. Only two warehouses need be constructed at first.

Machinery Conditions

Later devices consist in overhead trackage and transferring and hoisting machinery. The power is electricity, preferably of direct current. This can be purchased economically from the local electric light and power companies.

This conveying mechanism consists of a transfer tractor which draws after itself from one to four trailers, each trailer supporting an electric hoist. This transfer tractor constitutes the traveling conveying mechanism, having a speed up to 9 miles an hour with its complement of trailers and 6 tons of freight. It is controlled in the same way as an electric trolley car, by a transferman in the transfer tractor cab operating a drum controller, the current being taken by a contact wheel from a wire or other conductor located parallel to the track in the most convenient location, or in some special cases by a storage battery attached to one of the trailers.

Each trailer has supported beneath it an electric hoist, which might be called a traveling electric winch. It has all the functions of the winch except that it is movable. The normal load of each hoist is 2 tons at a speed of 60 feet per minute. There is a reserve capacity of 50 percent. Two hoists combined can lift 4 tons.

Advantages of such a Terminal

The same advantages that the city of Philadelphia enjoys will apply to this terminal. The proximity of the terminal to the great iron, coal and oil fields of Pennsylvania will make this large, modern mechanically equipped terminal a national point for vast and ever-growing manufacturing enterprises.

A Large Commercial Motor Boat

An unusually large gasolene (petrol) driven boat, which is named the *Radium*, was recently built by the Skinner Shipbuilding & Dry Dock Company, Baltimore, Md., and is now in the service of the Gulf Refining Company. Her dimensions are 153 feet length over all, 23 feet 10 inches beam and 12 feet 6 inches depth.

The vessel is built of steel throughout with the exception of the upper deck house, which is of wood and includes the pilot house, captain's room and cook's room. The lower house is of steel and includes the upper engine room, the entrance to the pump room, storeroom, engineer's room, deck hands' quarters and the galley. All of these quarters are located in the after part of the vessel and are well lighted and ventilated.

In the hull of the vessel there are five main transverse bulkheads and one vertical fore-and-aft bulkhead, all made oil-tight and providing eight compartments for cargo oil. The cargo oil is pumped from these compartments by four Gould "Pyramid" pumps, 6 inches by 12 inches, located in the upper engine room and connected by belt to a 20 horsepower horizontal gasolene (petrol) engine. These pumps can be arranged to be thrown in or out of gear by Orton clutches worked by levers. The suction and discharge of these pumps is 4 inches in diameter, and all valves in the cargo lines are 4-inch iron body brass-trimmed flanged gate valves.

The *Radium* has a displacement of 750 tons and on her trial trip, loaded, showed a speed of 8.4 knots. She has a fuel capacity sufficient for a radius of 1,800 nautical miles. The propelling machinery consists of a Standard air-starting and reversing single-acting gasolene (petrol) engine rated by the manufacturers, the Standard Motor Construction Company, Jersey City, N. J., as a 300 horsepower size, but which has been found capable of developing considerably greater horsepower. Two fuel tanks are located under the cargo pump space, having a capacity of 6,966 gallons. There is also a cylindrical tank in the engine room of 1,124 gallons capacity and a small tank for the pumping engine of 53 gallons. The total capacity of fuel tanks is therefore 8,143 gallons. Two air tanks, 18 inches diameter by 8 feet long, with a total capacity of 27.4 cubic feet, are located under the main deck in the engine room for supplying air for starting and reversing the main engine and for auxiliary purposes. In the after end of the engine room there is a fresh water tank of 507 gallons for supplying the galley. The vessel is lighted by a 2 kilowatt 7½ horsepower Standard gasolene (petrol) auxiliary engine, attached to which is a bilge pump and air compressor.

Oil tanker Radium, driven by gasolene (petrol) engines

Cross-Channel Steamers Equipped with Frahm Anti-Rolling Tanks.—The two new turbine steamers which are now being built for the Dover-Ostend service of the Belgian State Railways will be equipped with Frahm anti-rolling tanks. These are the first vessels engaged in the cross-channel traffic which are thus equipped. The installation of this device is expected to reduce the rolling of the vessels to an angle of not more than two or three degrees.

Motor Ship for the Atlantic Transport Company.—Announcement has been made recently that the Atlantic Transport Company is to place an order with Messers. Harland & Wolff, Ltd., Belfast, for a motor vessel of 7,100 tons displacement, to be equipped with six-cylinder, four-cycle Burmeister & Wain Diesel engines.

Petroleum Production in the United States.—According to figures published recently by the United States Geological Survey, the production of petroleum in the United States in 1911 was 220,449,400 barrels. The production estimated for 1912 was 220,200,000 barrels.

First Voyage of the Imperator.—Announcement has been made that the 50,000-ton Hamburg-American liner *Imperator* will sail on her first trip from Hamburg May 28.

McAndrew's Floating School

BY CAPTAIN C. A. McALLISTER*

CHAPTER VI

Boilers

"We have now covered the most important of the fundamental subjects which all engineers should know, so we will begin on the subjects relating to the parts you are most interested in, that is, those with which you have already had some practice. I will therefore ask you what, in the opinion of each, is the most important thing to take up."

"Propellers," promptly replied Pierce; "they drive the ships."

"No, sir," said Schmidt, "let's take up the engines, for they drive the propellers."

"I think we ought to begin with boilers, sir," remarked Nelson; "they furnish the steam which drives the engines."

"Ah!" said O'Rourke, "if that's the reason, let's take up 'the walking of the ghost' when he comes across with the money that makes 'em all go."

"Nelson," said McAndrew, "has the right idea—the boilers are the most important parts of marine steam machinery. If you don't get the steam first, no matter how good the engines and propellers may be, the ship will not move.

"I have already told you what happened when coal is put in the furnaces, and now we want to know something about the boilers that hold the steam after it is made. How many kinds of boilers are there, O'Rourke?"

"Two, sir," replied that youngster; "tight ones and leaky ones."

"Well, that's a good distinction, but hardly the kind that we want to talk about, although I'll admit that a tight boiler of any description is better than any kind that leaks. If you were to study books on the subject you would have to read descriptions of a dozen types of shell boilers, but as there is practically only one type used on steamers nowadays, any knowledge you might gain about discarded types would be as useful to you as last year's bird nests. The principal type of shell boiler all marine engineers in the merchant service have to deal with now is the Scotch type—single or double-ended. By the time you boys get to be chief engineers even that type will probably be put on the shelf, as the day of the use of watertube boilers is fast approaching. However, as the Scotch boiler is just at present the principal one to be considered, we will give that first attention. This boiler is named, probably, from the fact that it was first developed by Scotch shipbuilders, than whom," said McAndrew, evidently taking pride in his ancestry, "there are no better in the world.

"Up to the present time it has stood the test of service better than any others of the class of shell boilers, and has consequently lived to see the others discarded. Theoretically, an ideal shell boiler, to withstand internal pressure, would be one shaped like a sphere or ball, as curved surfaces need no bracing; flat surfaces should be avoided in boiler work, and the principal feature of a Scotch boiler, which makes it so efficient, is that there are as few flat surfaces as possible. The shell of the boiler is made cylindrical, the furnaces are cylindrical, as also, of course, are the tubes. Consequently, the only flat surfaces are the heads and portions of the combustion chambers.

"The thickness of the boiler shell depends upon three things: the steam pressure to be carried, the diameter of the boiler and the strength of the material used. The steam pressure has gradually been increased, so that now it is not uncommon to find Scotch boilers carrying from 200 to 250 pounds pressure; the diameter has increased so that boilers 16 to 18 feet in diameter are not rare. The time is not far distant when the shells will have to be so thick as to make this type impracticable; then you will see the watertube boilers come into greater use.

"In the early days of steam machinery, boiler building was a crude art. Compared with modern methods of construction it was in about the same relation as early wooden shipbuilding bears to modern steel shipbuilding. If a ship carpenter made anything that came within a half inch of the dimensions of the stick of timber he was shaping, he was supposed to be quite accurate. Old-time boiler makers were just about as crude; they rarely had drawings to follow, a rough sketch on a blackboard in the boiler shop sufficing; holes were always punched, and the drift-pin was used almost continuously. While such methods were all right for boilers using low steam pressures, they would not do nowadays at all. With the high steam pressures now used, and the large size of the boilers, nothing but accurate design and good workmanship will do. In the early days of boiler construction all rivets were driven by hand; now nearly all rivets are driven by hydraulic pressure of 15 to 30 tons, and even with that it is almost impossible to keep some of the seams and rivets from leaking.

"Here is a drawing (Fig. 1) of a typical small Scotch boiler which will show the general features of this type. It consists essentially of four steel plates rolled up into the form of a cylinder which is known as the shell of the boiler. Each portion of the shell is known as a course. The courses are lapped over one another and riveted together by what are known as lap joints. The longitudinal seams come together and are joined by straps or narrow plates on the inside and outside, the whole when riveted together being known as a butt-joint. In this shell are two, three, or sometimes four smaller cylindrical furnaces which are riveted to the combustion-chamber, a semi-cylindrical box with flat top, front and back, in which the combustion takes place.

"You will notice that these furnaces are not straight, but consist of a wavy contour. In this particular case they are known as suspension furnaces. Some of them have a series of corrugations rolled into them, the object of both types being to give them sufficient strength to withstand the crushing strain brought upon them by the pressure of the steam. It is much easier for a cylindrical tank or figure to withstand an internal or bursting pressure than it is for it to withstand an external or collapsing pressure, hence all furnaces (in Scotch boilers) subjected to high pressures of steam on the outside must be corrugated in order that they will not collapse under the pressure.

"From the combustion chamber to the front head are a number of small tubes, usually from 2 inches to 4 inches in diameter, through which the hot gases pass from the furnaces to the uptake and thence to the smoke stack. It is from these tubes where the greater portion of the steam is formed, as they are usually from 1/16 to ⅛ inch in thickness, so that the heat from the gases is very readily transmitted to the water which surrounds them.

"As the heads of the boiler and the larger part of the combustion chambers are flat, they must be supported or braced at intervals in order that they may withstand the pressure brought upon them. Later on, I will teach you how to space these braces or stays, as they are termed, as that is a question which will be asked before you can get your licenses.

* Engineer-in-Chief, U. S. Revenue Cutter Service.

"In the furnaces of a Scotch boiler the grate bars are arranged at about the middle at the front end and slope slightly downwards toward the back end. The length of the grates is generally about 6 feet, as that is about as far as a good husky fireman can work his fires properly. Sometimes they are 5½ feet or 6½ feet long, but in general you will find them averaging 6 feet in length. The capacity of the fireman in this respect really regulates the length of most Scotch boilers. Hence you will find that single-ended boilers very seldom exceed 11 or 12 feet in length, while double-ended boilers are generally about 20 to 22 feet in length—a double-ended Scotch boiler being practically two single-ended Scotch boilers placed back to back and joined together. As I said before, there are a number of other types of shell boilers, but as most of them are obsolete we will not waste any time on them."

"What's obsleet?" inquired O'Rourke.

"'Obsolete' means old-fashioned, not up-to-date," replied the instructor.

"I see," replied O'Rourke; "it's something like that hat Schmidt wears when he goes to see his girl in Fishtown."

'macaroni' boilers were those with large straight tubes, and 'spaghetti' as those having small, bent tubes. That is rather a good definition for the two main divisions of this class of boilers, but so far as different designs are concerned there must be two or three hundred, as every designer has his own ideas about getting up a watertube boiler. But these various kinds of boilers remind me of what they say about the fish in the waters around the Hawaiian Islands—there are 298 varieties, but they only use three of them to eat.

"In general, the main difference between Scotch and watertube boilers is that in the former the hot gases are inside the tubes and the water around the outside, while with the latter the water is inside the tubes and the gases around the outside.

"Watertube boilers usually consist of drums, headers and tubes, all inclosed in sheet metal casings. Usually there are one or two large drums on top and two or more smaller drums at the bottom, the tubes connecting the drums at the top and bottom. The feed water usually enters the boiler in the top drum, and is carried down to the lower drums through tubes or pipes known as down-flow tubes. Sometimes it flows down

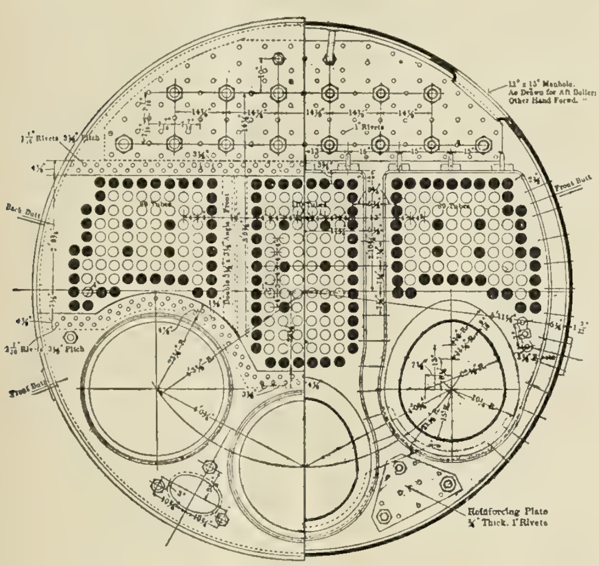


FIG. 1.—SCOTCH BOILER, END VIEW

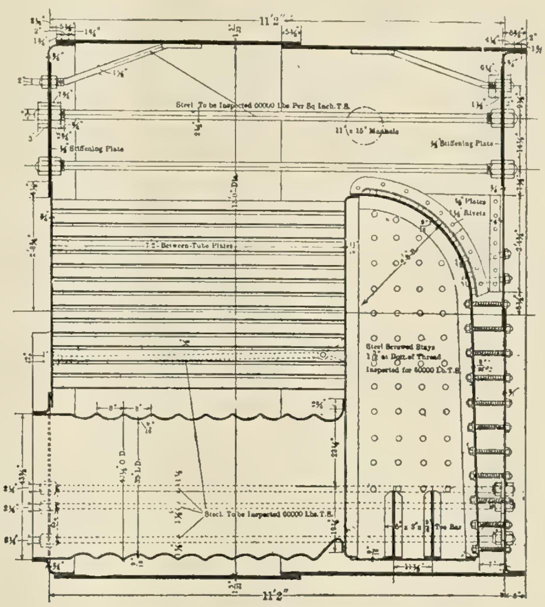


FIG. 2.—SCOTCH BOILER, LONGITUDINAL SECTION

"We will now look into the watertube boiler question a little. This type of boiler is having a hard time in overcoming the prejudice against it. At first they were used in swift steam launches and torpedo boats, on account of the great saving in weight as compared with shell boilers. Old-time engineers viewed them as a sort of a necessary evil in that respect and pitied the men who had to run them. The battle for supremacy in speed between the various nations finally led the more daring designers to use them in some swift cruisers and gunboats. As no great harm seemed to have come of this, the more progressive designers finally adopted this type of boiler for battleships. Old-timers shook their heads at this move and predicted dire disaster for the ships thus equipped. However, the results have been so satisfactory that to-day every new battleship throughout the world is fitted with watertube boilers, and they are giving the greatest satisfaction on account of their many superior qualities.

"O'Rourke, you of course know something about watertube boilers; how many classes of them do you think there are?"

"I don't know much about them myself," replied the young man, "but I heard a fellow out in the shipyard say to-day that there were two kinds, the macaroni and the spaghetti, whatever they mean."

"Ha! Ha!" laughed McAndrew. "I suppose he meant

through the tubes themselves. In any event a rapid circulation is started up between the water in the lower and upper drums or headers. As the water passes up through the tubes, globules of steam are formed which, discharging into the upper drum with the water, are separated by baffle plates from the water and pass out through the dry pipe into the main steam pipe. The tubes in which the steam is formed are known as generating tubes to distinguish them from down-flow tubes when such are fitted to the boiler. Watertube boilers are usually rectangular or box-shaped, as the casing surrounds the tubes and the furnaces. In order to prevent the sheet metal casing from burning, it is usually lined with asbestos board and fire brick. Large tube boilers are those which have generating tubes 3, 4 or sometimes 5 inches in diameter. Boilers built of tubes 1 to 2 inches in diameter are classed as small tube or 'spaghetti' boilers, as O'Rourke's friend would say.

"Some engineers prefer one type and some the other, but if I had anything to say about fitting watertube boilers to a merchant vessel, the tubes would be as large as practicable and straight or nearly straight, so that they can be cleaned and examined."

"Why don't shipowners use watertube boilers in merchant vessels?" inquired Nelson.

"That's hard to answer," replied the Chief, "but I suppose it is for the same reason that many people refused to ride on the elevated road when it was first constructed in New York. They had been brought up to ride in corse cars on the streets: they knew they were safe and sure, and although they could ride faster on the elevated, they preferred the safety which they knew of, rather than to take a chance on the more modern means of transportation of which they were afraid. Such a trait of mankind is known as conservatism, and it is an excellent quality until it is carried to excess, when it becomes foolishness.

"The advantages watertube boilers have over Scotch boilers are many. The weight of a watertube boiler, with water, is just about one-half that of a Scotch boiler under the same conditions, thus giving that much more cargo-carrying capacity. Steam can be raised in a half hour, as compared to four to six hours for raising steam in a Scotch boiler. There is less danger from a serious explosion, as the parts of a watertube boiler liable to explode are much smaller than the great bulk of a Scotch boiler, under pressure.

"A watertube boiler need never wear out entirely, as the various parts can be renewed as necessity requires. When a Scotch boiler wears out, it must be renewed in its entirety, and generally at great expense on account of tearing away the decks and joiner work above the boiler space.

"Watertube boilers can be forced much harder, with safety, than Scotch boilers, as they are in a manner flexible and can stand severe usage which ordinarily starts a Scotch boiler leaking.

"One of the main features which would appeal most, just now, to you boys, is the matter of cleaning. In watertube boilers there are no back connections to sweep—a task which makes the life of an old-time chimney-sweep seem easy in comparison—no crown sheets to clean and sometimes scale, no cleaning of the inside of the boiler, where a man must go through contortions like a ferret to get at the heating surfaces. I doubt if any more disagreeable job could have been devised in the days of the Inquisition than that which befalls the lot of a marine fireman when it is boiler cleaning time on board a ship fitted with Scotch boilers. Surely there is nothing which more discourages men from going to sea. No wonder engineers hurry and get fat as soon as possible, so that it is a physical impossibility for them to get through a 12 by 15 inch manhole. If the stokers and coal passers could vote on the type of boiler to be used, I am afraid the Scotch boiler would soon get in the class with Schmidt's hat.

"The disadvantages claimed by opponents of watertube boilers are that it takes more skill to tend the feed on account of the smaller quantity of water in the watertube type. This, I am told, is more imaginary than real, although it must be admitted that a water tender must be onto his job at all times and keep his eyes on the glass. So, too, should a water tender with any other type of boiler, as that is a duty where day dreaming does not go. It is also claimed that strictly fresh water must be fed into watertube boilers at all times, but, as a matter of fact, that is so with a modern Scotch boiler if its efficiency is to be maintained. The care of marine boilers of any type is one of the most important duties on board ship. Carelessness on the part of anyone connected with the handling of boilers is not only dangerous to all on board, but frequently results in large repair bills and operating expenses. The most successful engineers are those who keep the boilers in good condition and operate them intelligently."

CHAPTER VII

Boiler Fittings

"How many fittings are there on a marine boiler?" inquired McAndrew.

"Four, sir," said Nelson.

"Only four, eh? Well, what are they?"

"The steam gage, gage glass, shovel and slice bar," replied Nelson.

"Oh! come off," said O'Rourke, "the shovel and slice bar are what the highbrows call the 'implements of your trade'—they're not fittings."

"Well, O'Rourke," said the teacher, "how many do you think there are?"

"Oh! at least half a dozen," replied he, "but for the life of me I can't think of their names just now."

"O'Rourke, you remind me of the fellow who, when falling off the water wagon, paused in the act of taking a drink and said, 'There are a dozen good reasons why I shouldn't drink this whiskey, but for the life of me I can't think of one of them now'—and then he took the drink. I don't think you have tried very hard to think of the necessary fittings on a boiler, but, at any rate, I'll remind you of some of them.

"You all know of the safety valves, which are generally made in pairs and are bolted to the highest part of the boiler. The old-fashioned safety valves were of the ball-and-lever type, but they are not used to any great extent these days, as they are poorly adapted for high pressures, or in fact for use on shipboard at all. One of the most important duties about the fireroom is to see that the so-called easing gear for lifting the safety valves off their seats is kept well oiled and in good working condition. At least every other day the valve should be lifted off its seat for an instant to see if the springs are working well. It might be necessary to open the safety valves in a hurry some day, and if the gear is not kept in good condition they would fail at the critical moment.

"The stop valves on boilers are very important fittings, as they control the passage of the steam to the engines. On every boiler you will find a large valve known as the main stop valve, and a smaller one, the auxiliary stop valve. These valves, too, should have their stems lubricated and kept in such condition that they can be worked easily. In this connection I want to warn you young men against opening a stop valve on a boiler suddenly—many a good man has gone to Kingdom Come by not bearing that in mind. You must remember that a sudden release of steam often causes large gulps of water to be carried with the steam through the valve and into the steam pipe, where a water hammer is instantly formed and often with the result of bursting the pipe. Even if no water is carried out with the steam, the pipes are cold, and the sudden condensation results also in a water hammer. When you open a stop valve, just 'crack' it at the start—by that I mean to turn the handwheel a mere trifle until you can hear the steam hissing through the slight opening. Then wait until you can count at least 200 before you give it another slight turn."

"It's too hot up there to be counting very much," interjected O'Rourke.

"Yes, but it isn't nearly so hot up there as the place you might go to if you opened the valve suddenly," said McAndrew.

"We have seen how to get the steam out of a boiler, but after all it is of even greater importance to get the water into it, for if you fail to keep the water flowing into a boiler under steam, there would soon be something doing.

"Schmidt, do you know what a check valve is?"

"No, sir," replied he, "I don't know just what it is, but I know where it is, and I know that you open it to let the water in the boiler after you start the feed pump."

"That's something to know," continued McAndrew, "but like a certain brand of breakfast food, 'there's a reason for it.' A check valve is one which allows water to pass in only one direction—that is, from the pump to the boiler. It is made that way so that in case the feed pipe should burst, the scalding hot water and steam from the boiler would not rush out through the opening in the feed pipe."

"I'm on," said O'Rourke, "it's like a one-way ticket to

Coney Island—you can get down there all right, but you can't get back if you blow in all your money."

"Recently all marine boilers were required to have two separate openings in the shell and two separate check valves, a main and an auxiliary, to regulate the admission of the feed water, so that if one gives out the other can be used. There is also a stop valve located between the check valve and the boiler shell, so that in case of accident to the check valve the stop valve can be closed and repairs made to the check. It pays to take every possible precaution in regard to such an important matter.

"After we have provided means for getting the water in and the steam out of a boiler, the next thing in importance is to have some way to ascertain the level or height of the water in the boiler. Here, too, every precaution must be taken, for it is a very serious matter. You all have seen the gage glasses and how careful the water tenders are to watch the level of the water in them. The gage glass is, therefore, the most important of the means employed for determining the water level. As a further precaution, there are four gage cocks usually fitted on the side or in the front of the boilers at about the desired water level. I must confess that it is very difficult for anyone, except a locomotive engineer, to tell exactly the water level by means of these cocks. It takes a trained eye and a trained ear to distinguish between the steam and water when a ship is rolling. The locomotive engineer has to depend on gage cocks almost entirely, as it is impracticable to fit gage glasses on a locomotive. On board ship the men rely almost entirely on the gage glass, so they do not get much practice with the try cocks. I would rather take my chances by having two gage glasses fitted, as it is almost certain that both glasses will never be broken or out of order at the same time."

(*To be continued.*)

British Battleship Benbow

The British battleship *Benbow*, which is now under construction at the naval construction works of the Messrs. Beardmore, of Glasgow, is one of the four armored vessels of the 1912 programme. Her dimensions are as follows:

Length between perpendiculars	580 feet.
Beam	89 feet 6 inches.
Mean load draft	27 feet 6 inches.
Displacement at load draft	24,000 tons.
Designed power of turbines	33,000 S. H. P.
Designed speed	22 knots.
Coal capacity	3,000 tons

Armament—Ten 13.5-inch guns and sixteen 6-inch guns.

The ship is 90 feet longer, has 7 feet 6 inches more beam, 1 foot greater draft and 6,000 tons greater displacement than the *Dreadnought*.

The main propelling machinery consists of two sets of Parsons steam turbines designed for 33,000 shaft horsepower. Each set consists of one high-pressure ahead and one high-pressure astern, and one low-pressure ahead and astern combined turbine. The turbines are arranged in three watertight compartments; one high-pressure ahead and one high-pressure astern, fitted to the same shaft, are arranged in the outer compartments and both low-pressure in the center compartment.

All of the turbines are controlled from the center engine room and connections are arranged so that, in the event of either or both side engine rooms being disabled, the ship can be driven with only the low-pressure turbines. There are four shafts, each fitted with a solid bronze propeller.

The main condensers are arranged in the center engine room, one for each set of turbines. They are of the Weir Uniflux type, and the large circulating pumps of Allen's centrifugal type are fitted to each. Two of Weir's Dual air pumps are also fitted to each condenser.

A complete system of forced lubrication has been installed for the supply of oil to the turbine and shaft bearing blocks. Powerful overhead travelers are arranged on girders on the underside of the lower deck, over each shaft, for lifting the upper half of turbine casings and the turbine rotors when necessary.

The usual auxiliary machinery is provided. Powerful steering engines in duplicate are arranged in the engine room, connected by means of shafting and gearing to the rudder heads and controlled from the steering positions by telemotor gear. An auxiliary condenser, evaporator and distilling plant feed pumps, fire and bilge pumps, oil fuel pumps, and forced draft fans are also fitted. There are also air compressors for torpedo service, and hydraulic pumping engines for the gun machinery and the hydraulic boat hoists. A steam-driven capstan and windlass is fitted forward, and several electric coal-hoisting winches are placed on deck.

Steam is supplied by an installation of eighteen Babcock & Wilcox boilers. They are of the latest type, designed for burning coal and oil fuel, and are arranged in three watertight compartments.

As regards the armor of the ship, it extends for practically the full length of the hull, being 11 inches thick from about 5 feet below the water line to near the upper deck, while the top strake of armor is 9 inches thick. Toward the stem and stern the thickness is reduced. Heavy armored bulkheads extend across the ship at the forward and after ends of the thick side armor, in order further to protect the barbettes, which are of 12-inch armor. The conning tower is also constructed of 12-inch armor.

Like all the previous dreadnoughts, the *Benbow* has a high forecastle, so that the forward 13.5-inch guns are mounted at a great elevation. All the guns are mounted in pairs on the center line of the ship, this arrangement giving a broadside fire of ten guns, an ahead fire of four guns and a fire astern of four guns. The anti-torpedo boat armament of the *Benbow* is a novel feature. There are sixteen guns, as in all the earlier super-dreadnoughts, but they are of 6 inches instead of 4 inches caliber. The adoption of the 6-inch gun is a reversion to the idea of secondary armaments. The ship has three submerged torpedo tubes, each capable of firing 21-inch torpedoes, and to protect her from torpedo attack there are torpedo defense nets all fore and aft.

The propeller shafting passes through the ship's hull, and each shaft is carried in stern struts of the A type. The two rudders are of the balanced form, unsupported outside of the hull, the weight of each rudder being carried on the lower deck.

In outward appearance the *Benbow* resembles the *Dreadnought*, having two stacks and one mast. The sister ships are the *Iron Duke*, laid down at Portsmouth dockyard, the *Marlborough* at Devonport, and the *Delhi* at Vicker's yard, Barrow.

New York Motor Boat Show

The ninth annual New York Motor Boat Show was held in the Madison Square Garden, Feb. 15 to 22. The exhibits included nearly every type of motor boat from small powered cruisers to large cruisers and the speediest racing craft, marine motors of practically every type on the market, from the smallest single-cylinder engines to the highest powered heavy-duty engines, and the host of accessories which go to make up the equipment of a successful motor boat. Marine engines for motor boats never have, and probably never will, approach a recognized standard of design, as has been the case with the steam engine, and for this reason the annual Motor Boat Show is of particular value, as it gives an opportunity to study at first hand the developments and improvements which are continually being made in design.

Letters from Practical Marine Engineers

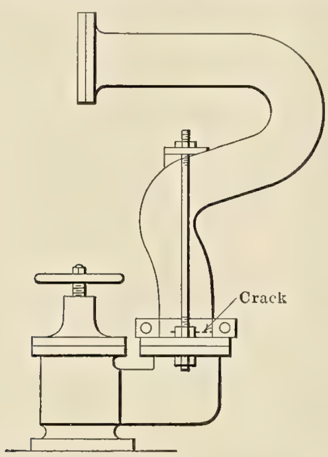
Incidents Relating to the Design, Care and Handling of Marine Engines, Boilers and Auxiliaries; Breakdowns at Sea and Repairs

A Varied Experience

The following is an interesting and, I venture to say, instructive, incident that befell me some years ago while a member of the staff of engineers on board the steamer *Wearside* on a memorable and never-to-be-forgotten voyage from Rotterdam to Sandy Hook for orders.

To begin with, we were running light, and as it was the month of February, we knew from past experience that the Atlantic at that time of the year was in anything but its best mood, and especially to a ship which was for all the world like a cork upon the water.

Though I have crossed the "herring pond" many times since, not only in a first-class cargo boat, but also in monsters like the *Lusitania,* I have never encountered a voyage nor seen seas to equal the occasion of which I write. I often look back with wonder that we ever reached the good old Hook at all.



METHOD OF REPAIRING CRACKED STEAM PIPE

Well, the weather showed us in the first few hours after we got clear of the land what we were to expect, and those of us who were inclined to think lightly of it were very forcibly reminded by the roar at almost regular intervals from the engine room, when the engines were engaged in trying to pass each other, that the ship would have been a good substitute for a hydro-aeroplane. First, she would roll hard to starboard and wallow in the trough of the sea, then she would swing hard aport until one began to wonder whether she would ever right herself. She never seemed to tire of this, and would pitch her old stern out of the water between times until it seemed to those on board as though she were taking a header to the bottom. Of course it was hard work cooking in the galley, and we all pitied the poor cook, but were inclined to be tickled over the idea of his having to grip pots and pans in a wild endeavor to keep them on the stove until the "Messroom" capsized our joint over the side, in an ill-fated trip from the galley, and then we had to be contented with a tin of "Harriet Lane" for our dinner.

Meanwhile the wind was shrieking like a thousand fiends and on all sides nothing could be seen but mountains of water. We had a solid eight days of this, and were told the cheering news that we were only 180 miles from the English Channel. Then things began to get serious, as our coal was steadily being consumed and little or no headway was being made. Then it was that the chief engineer gave one of those puzzling (to landsmen) orders, "Go slow to save coal." We were accordingly slowed down to little more than quarter speed. Even at this rate the engines still continued to roar out their challenge to the sea, and we engineers hardly dared leave the throttle for fear of a smash-up. But instead of letting up things got worse, and finally came the order from the bridge, "Stop."

It was useless battling against such seas, and the old man ordered us to stop in the hope that the weather would moderate. The wind did moderate a little, but the sea got worse, as it always does when the wind drops. Anyhow, as we could not stay there forever, a fresh start was made some few hours afterwards. It was my watch below as we started, and we had hardly been under way more than a couple of hours when a heavy pounding of the feed pumps and continual discharge from the hot well overflow, coupled with the heavy lifting of the feed pump relief valves, convinced me instantly that we were up against it. I immediately put the auxiliary feed pumps in service to deal with the condensed water, and the chief was summoned and a halt called.

We examined the port feed pump, which was of the plunger type so common to marine engines, and we found, on examination that the suction valve was loose, and lifting with the valve at each stroke. We had no spare ones, so a joint was made of red lead and marline and the seat jammed back into its place. We then drilled a ⅝-inch tapping hole through the casting of the pump chamber, and fitted a screw bolt to set up on the seat, thus preventing effectually, it proved, any further annoyance from this source.

Once more a start was made, much to the relief of the engineers, as it is no joke working under such trying conditions, as with the main engines stopped the leaks from various causes soon filled the bilges, and not a very pleasant time was afterwards spent clearing the "strum" and "mud boxes" of ashes, grease, etc., which, with the vessel rolling and pitching as she was, got washed off the tank top down into the bilges, thus choking the bilge pumps.

We were doubled up now on six-hour watches, the chief and myself and the first and second assistants. It was some four days after the incident just related, about 1.30 A. M., exactly one and a half hours after the chief and I had gone above for a much-needed rest. We carried no "greasers" and the engineers were required to do their own oiling, and those of my readers who have had any experience of clinging to a handrail on an open front type of engine with one hand, holding a duck lamp in the same hand and an oil can in the other, waiting for the ship to roll, so that you can hit the oil cups and incidentally get some drops of scalding water down the back of your ear from a leaky piston gland, will know what I mean when I say "a much needed rest" after six hours of it.

To continue. I was asleep, it seemed like only five minutes, when the first assistant burst into my berth with "Hey! get up and come down at once! Hurry up!" Needless to say, I got up in jig time, wondering what was wrong, and went down below. Somehow I did not feel surprised to find the engines slowly turning the centers, but I was surprised and, I may add, a good deal nervous, when I was told "It's the center main steam pipe."

It was only too true. Worn out by the continual vibration due to the incessant racing of the engines, the good old copper main steam pipe, ¼ inch thick, had given way under the strain, and the ominous hiss of escaping steam could be distinctly heard up on the boiler tops, while each race of the engines, though comparatively small now, literally jarred our nervous systems. We felt like men facing death at any moment, as the chief, who took a squint at the fracture from the door just ajar leading on to the top of the boilers, returned with the news that the pipe was cracked more than two-thirds of the circumference.

All fires were immediately banked, and we proceeded to the nerve-racking process of shutting the main stops on the boiler mountings, and of course in the immediate vicinity of the damaged pipe. It was accomplished at last after the saying privately by us all of a good many prayers, as of course we had to take spells owing to the stiffness of the valve, to say nothing of the heat, as it was not possible for one man to do the job, nor was it expected of him, and it takes a good deal of screwing up of courage to stand alongside an 8-inch steam pipe, knowing same to be cracked and liable to blow bodily off at any minute, and shut a valve down to, say, about 26 turns.

When the stops were shut, however, and the engines at rest, we breathed easier, though we knew we had a hot job before us. I have made a sketch of the way the chief decided to repair the pipe, which was roughly shaped like a question mark. The fact that the crack was very near the flange made patching no easy job. A clamp of ⅝-inch by 2-inch flat steel was made to fit the pipe and passed over the crack and as near the flange as the heads of the joint bolts would allow. This was screwed up as tightly as possible over an asbestos cloth joint, by means of the two ¾-inch bolts in the lugs of the clamp. This arrangement was to take care of the steam which would escape from the crack.

Now, to prevent the pipe from blowing off in the event of the fracture extending right around the pipe was the next step. To meet this emergency, two bolts were taken out of the joint and an old fire rake handle was cut into two pieces, each 3 feet long, and screwed at each end about 9 inches. These, with nuts to fit a ⅞-inch rod, were substituted for the bolts just removed, and a bridge piece of flat stuff was made to cross over the bend in the pipe and engage with the bolts. The whole was then screwed up tightly.

This arrangement lasted very well for some time, but the bad weather, with consequent racing of the engines, continued, and finally a halt was made and the pipe taken off bodily. Two ¾-inch steel blanks were made to fit the flanges on the boiler mounting and three-way tee. The fires of both the center and starboard boilers were drawn and the boilers blown down, and by stripping the boiler deck steam stop valve on the wing boiler, and leaving out the valve, which was of the non-return type, and the center boiler deck stop valve being left open, we thus established connection between all three boilers again, and did not leave the center boiler idle.

While this job was in progress we were hove to, at the mercy of wind and wave, and it must have been this fact which prompted the "Master" of that fine steamer *Kaiser Wilhelm der Grosse* to ask us if all was well as she passed, which she did in a few minutes, so to speak, though the sea was running very high. We replied, "Yes! all safe," and when, half an hour afterwards, all one could see of her was the smoke trailing away on the horizon, we felt as though we had lost a friend.

We had to make St. Michaels, in the Western Islands, for more coal, which we just managed, and exactly thirty-one days six hours from leaving Rotterdam, we crawled up to Sandy Hook, a very battered and rusty tramp, but containing in her engine room four tired but thankful engineers.

Perth Amboy, N. J.

C. Carl Weddell.

Why the Cost of Life-Saving Appliances on American Ships has Increased

During the last year the matter of life-saving appliances has been most thoroughly considered by the Supervising Board of Inspectors, and many new regulations have been made by it with the view of providing better means of safety at sea.

The changes made have, there is no doubt, resulted in far more efficient apparatus for life saving being fitted in all ships. The new regulations have, however, materially increased the cost of such appliances, and shipowners are fairly staggered by such advances. It is my purpose to show that these advances are not due to an arbitrary advance by the builders of apparatus, but simply to the fact that the new regulations demand certain changes. For instance, one size of life raft was, under the laws of the Board of Supervisors, allowed to carry 28 persons; the rules to-day allow only 15 persons to the same size of raft. Here, at once, is an advance of almost 100 percent in cost per person. To make it clear, under the old rule this raft would cost the shipowner $6.08 (£1 5s. 4d.) per person, while to-day it would cost him $11.33 (£2 7s. 2½d.) per person. Here there is no advance in price by the raft builders.

There has been a steady advance in the material used in raft building, and corresponding advance in price, which on the average would bring it up to $12 (£2 10s.) per person. No fault can be found, if a moment's thought is given, with the builders, and it is hardly fair to say that the Board of Supervisors has arbitrarily made the reduction of persons carried, as they are all painstaking gentlemen who have gone into the matter of safety with the greatest care and arrived at their conclusions after mature reflection and due consideration of real life-saving appliances.

The great height of the deck of modern ships from the water has precluded, in most cases, putting a lifeboat into the water and then filling it with passengers. It therefore became necessary to build a boat able to stand its load of persons while cradled in its chocks or swung out, and a steel keel is now used to give the required stiffness to stand this load.

In the metallic lifeboat, under the old rules, two watertight air tanks were demanded of certain capacities. These were built into the bow and stern, the skin of the boat forming two sides of the tanks with a deck and vertical bulkhead forming the other two, the air capacity being about 38 cubic feet, 62 cubic feet being required under the new law. To-day the same size of boat must be fitted with ten independent air tanks. Now, what does this mean? First, a boat which can withstand far more damage without sinking, as it is quite impossible to have more than one, or at most two, of the air tanks punctured at the same time—in fact, it seems to me that they could not be punctured under any condition, but only dented without materially injuring them as a buoyancy medium. On the other hand, the following will show where it affects the builder and shipowner:

In one size of lifeboat the old system of air tank required 90 pounds of galvanized sheet metal and two connections for testing. The new tanks require 384 pounds of material and ten air test connections, with extra expenditure in time and material to secure the tanks in the lifeboat.

All the fittings about lifeboats have been made heavier, and the material in some cases changed from malleable iron castings to steel forgings. Again, to the shipowner the requirement of accommodation for all on board, either on life rafts or in lifeboats, results in an enormous number of these appliances being supplied, or a very great reduction in carrying capacity of passengers. In one case there is a seriously increased investment, and in the other a serious decrease in earning capacity.

Shipowners have the erroneous idea that this advance goes into the pockets of the builders. It is very plain to see that

TABLE I.—DIFFERENT LIFEBOAT ARRANGEMENTS WITH WELIN QUADRANT DAVIT-LUNDIN DECKED LIFEBOAT—STANDARD LIFEBOAT

Arrangement.	I. 1—28-Foot Standard Lifeboat, "A" Davits.	II. 2—26-Foot Lundin Lifeboats, Nested, "A" Davits.	III. 1—26-Foot Standard Lifeboat, "B" Davits.	IV. 2—24-Foot Lundin Lifeboats, Nested. "B" Davits.	V. 1—26-Foot Standard and 2—24-Foot Lundin Lifeboats, "DA³" Davits.	VI. 4—24-Foot Lundin Lifeboats, Nested, "DA³" Davits.
Persons	50	100	40	80	120	160
Deck space, including davits, square feet	272	264	234	225	468	495
Deck space per person, square feet	5.44	2.64	5.85	2.8	3.9	3.1
Length of deck	32′ 6″	30′ 6″	30′ 6″	28′ 2″	30′ 2″	29′ 2″
Total weight, including chocks, pounds	7,800	11,900	6,350	9,750	13,300	16,700
Weight per person	156	119	160	122	112	104
Weight per square foot of deck	29	45	27	43.5	28.5	33.5
Total cost, including chock fitting	$1,319	$2,845	$1,171	$2,437	$3,283	$4,549
Cost per person	$26.40	$28.45	$29.30	$30.50	$27.25	$28.30

TABLE II.—COMPARATIVE TABLE.

Arrangement.	Weight per Person.	Space per Person.	Length of Deck per Person.	Cost per Person.
II:I	76%, gain 24%	48½%, gain 51½%	47%, gain 53%	107½%, loss 7½%
IV:III	76%, " 24%	47½%, " 52½%	47%, " 53%	104%, " 4%
V:III	70%, " 30%	66⅓%, " 33⅓%	33%, " 67%	93%, gain 7%
VI:III	65%, " 35%	53%, " 47%	24%, " 76%	96½%, " 3½%

ten independent air tanks requiring such an advance in materials must require a very great advance in the wages paid for their construction. Each tank has to be formed, lock-seamed and soldered, furnished with test connections, made fast, and a plate stating its cubic capacity soldered on it, and, further, means must be provided to suspend and secure these tanks and place them in position. All this advance in cost, save a very small increment to meet additional overhead charges, goes into the pockets of the workmen—in fact, those who benefit most by the new rules are the workmen.

Of course the traveler is better protected, his safety is made greater; this being the fact, it seems to me only fair that those who run ships and steamers have a right to make an advance in their passenger rates. It is all very well to say that these life-saving appliances should have been provided long ago, and that now that the law requires real safety no advance should be made because such is provided. The record of the past shows beyond all question that American ships in foreign trade have not been able to make money under the old laws, and the proof is that they have faded from the "face of the deep and are no more known." With only a slight increase in passenger rates the additional investment required in installing adequate life-saving appliances for all on board as specified by the Board of Supervising Inspectors could easily be defrayed without the necessity of cutting down the number of passengers carried at the former rates.

Lifeboats were sold in the United States up till last year at one-quarter less cost than in other countries. As a matter of fact, this was the sole case where American equipment of any kind was disposed of at a figure below foreign prices. The reason for this was that the lifeboats, as then made, were not as well constructed as those built abroad. In the effort to keep the American merchant marine on the water at all, the cheapest possible equipment was demanded, and the laws did not demand a really first-class product. To-day it requires a boat construction which, while high in cost, is of a vastly higher grade. It is rather strange to hear it argued that the new laws are all unnecessary for American ships, as they are very safe and always within short distances of help on shore, yet the people who so argue admit that there are cases where lifeboats are called upon to do the work that their name implies, but, when it comes down to "brass tacks," the real objection seems to be the increased cost only. Now it should be remembered that when a lifeboat is wanted the very best obtainable is none too good, and no practical sailor will gainsay this. The man who has to handle an appliance in which he does not feel absolute confidence is not at ease, nor is he able to do his best, and none but those who "go down to the sea in ships" can understand the feeling that overtakes a man amidst the rushing waters, waves and howling winds if he doubts the tools with which he has to work. It took a terrible disaster to impress the world with the condition which existed as to lifeboats and means of handling them, and the present laws which resulted from that disaster have made for far greater safety at sea, and the only objection that I have heard raised against what is now demanded is the increased cost of life-saving appliances.

In Table I is shown, at a glance, a most interesting exposition. Here the cost of a 28-foot standard lifeboat, together with its required Welin davits, including chock fittings, comes to $1,319 (£270), or a cost per person of $26.40 (£5.42). This size of boat accommodates 50 persons, taking 272 square feet of deck space, or a deck space of 5.44 square feet per person. The length for boat and davits is 32 feet 6 inches, a total weight of 7,800 pounds being required, which gives a weight per person of 156 pounds, all included. In this case the deck has to carry 29 pounds per square foot. It will be noticed that nested Lundin decked lifeboats give the least weight per person, and the least required deck space. The standard lifeboats used single require about twice as much deck space. Table II gives an interesting comparison of the different arrangement of boats and davits tabulated in Table I.

New York. W. D. Forbes.

A Shop Kink

The threaded seat of a large stop valve connected with a battery of boilers had become loose on account of the threads being worn away. To remove the valve from the boiler meant the expenditure of considerable time and work, as the bolts had become cemented by rust. Considerably more time would be required to take the valve down, haul it to the machine shop, set it up in a lathe, rebore and cut it, so it was decided to do the job with the valve in place. A piece of iron was obtained and holes were drilled to bolt it to the flange on the valve body. A hole two inches in diameter was then bored and threaded twelve threads per inch. With a piece of round iron a boring bar was rigged up with a hole in the end for the cutter, which was secured by set screws. A square-nosed tool was used to remove the old worn threads. The hole was made true, and then a V-thread cutter was put in for the first cut. For the next cut the cutter was removed and the bar returned to the starting point. The cutter was then inserted and another cut was taken. After the operation had been repeated several times a good thread was secured.

The new seat was turned and threaded to a good fit, and all was done in a comporatively short time without disturbing the valve.

LATHE HAND.

The Possibilities of the Marine Oil Engine

An article by Mr. Lucas on the producer gas engine as a solution of the problem of marine propulsion, which came out in 1903, together with a similar article by Mr. Nixon in *Cosmopolitan,* was the inspiration for a communication which was published in the December, 1904, number of the MARINE ENGINEERING. In that communication I told what could be accomplished by the use of the heavy oil engine, and reference to that article will show that my description reads very much like the articles we are now reading about pioneer Diesel-engined ocean vessels.

I differ from Mr. Lucas now as then, but in a different degree. It may be interesting to compare my ideas with those of Mr. Lucas as they came out in the February, 1913, issue of INTERNATIONAL MARINE ENGINEERING.

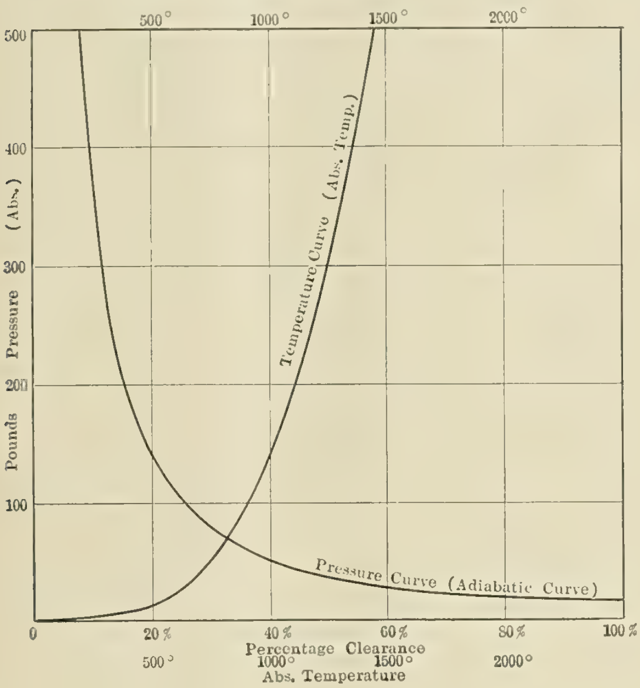


FIG. 1

The advantages are:

1. Small space. I brought this point up in connection with the gas producer type of engine. The producer will be very near the size of a steam boiler, if not larger.

2. The matter of weight is not in the weight of the engine. If the oil engine plant is as heavy as the steam plant it still has a very great saving in fuel weight. A pound of coal has 14,500 B. t. u. against the 19,500 B. t. u. for oil. The efficiency of the oil engine is about 25 percent against the 12 percent for the steam plant. This means that one ton of coal can be displaced by 850 pounds of oil.

3. The rapidity with which full power can be developed when the engine is running light.

The disadvantages are:

1. The absence of steam for the auxiliaries and for heating purposes. The employment of gasoline (petrol) is not a disadvantage, for gasoline (petrol) should not be used in the oil engine. It can be used if it is on board and the regular fuel supply is exhausted.

In my early study of the heavy oil engine I wondered why Dr. Diesel did not patent the method of procuring combustion by means of the heat of compression. I found that Beau de Rochas discovered this method or described it in 1862. The explosive method I do not think can be used in the oil engine. To use a spark there must be a gaseous mixture. This means a gas must first be made of the fuel, which then converts the engine into a gas engine.

In vaporizing the fuel, as stated by Mr. Lucas, two classes were mentioned: (1) The hot chamber or shield vaporizing type; (2) mechanically atomizing type.

Personally I have no use for the hot chamber type. That has been worked out by several engineering firms in the last twenty years. I should be afraid of a layer of soot forming on the hot surface which might interfere with the action of the surface. Second, with this method the combustion must spread from a certain locality. This will mean a slower combustion.

In regard to the mechanical atomizer, it does not help you.

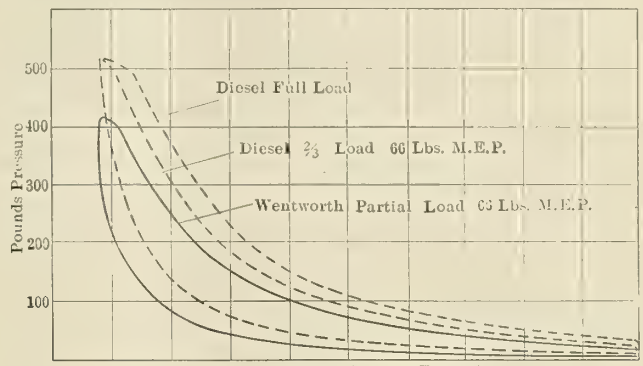


FIG. 2

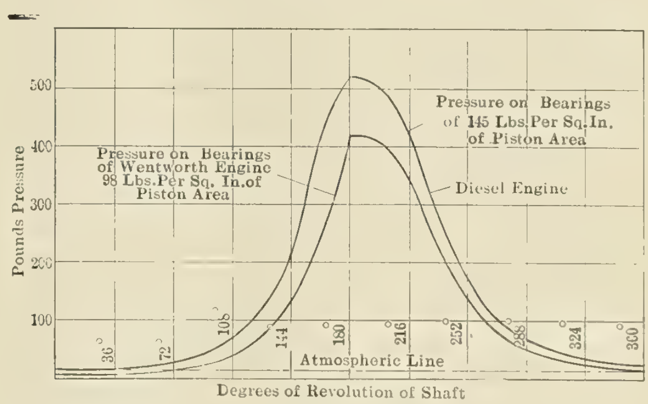


FIG. 3

When you have your spray in the engine you must then ignite it. The ignition of a large engine must come from the temperature of the air. This can be obtained in two ways:

1. By the de Rochas method of compression of cold air to a point where the ignition temperature of the fuel will be reached.

2. By the Wentworth method, where this temperature will be arrived at by a combination of the temperature of compression added to a certain degree of preheat. So far as I can find, this method had never been proposed prior to the time I developed the design enough to submit this to the U. S. Patent Office.

Fig. 1 will enable anyone to figure out what this preheat will do. If it is assumed that the incoming air has a temperature of 60 degrees Fahrenheit (520 degrees Fahrenheit absolute) and the engine is to ignite at 250 pounds pressure, it can be seen from the curve that 500 pounds pressure will give a temperature of 1,450 degrees Fahrenheit absolute. At 250 pounds the temperature of compression is 1,200 degrees Fahrenheit absolute. The needed increase in temperature is 17 percent. Seventeen percent of 520 degrees Fahrenheit is 90 degrees preheat. Ninety degrees added to 60 degrees will mean that if the air is preheated to a temperature of 150 degrees Fahrenheit, or 610 degrees Fahrenheit absolute, the same temperature can be obtained at 250 pounds pressure that the so-called Diesel engine gets at 500 pounds pressure.

Mr. Lucas has shown us diagrams for the ahead and backing operations. I take exceptions to his diagrams. Perhaps I read his diagrams more closely than he intended them to be read. He has given us degrees, and so I think I am right to infer that he intended exactly what is shown. The fuel injection is shown as 22½ degrees. The injection begins exactly at dead point. Now I believe in following the beaten paths unless there is a good and sufficient reason for leaving them. We find that advancing the spark in the gasoline (petrol) engine gives good results. The explosion in the gasoline (petrol) engine is more rapid than the combustion in the heavy oil engine. You can get no combustion in the oil engine till the fuel is fed in, and then it can only burn as fast as it is injected. You may judge that I hold no brief from the Diesel interests, so I cannot speak for the reason why they do things. I judge, however, that the fuel is not fed in ahead of the dead point more because they already have all the pressure they care to handle in the engine. As a result, they are willing to sacrifice something of the efficiency of the engine in order to save on the wear and tear of the engine. In my experimental engine I have increased the pressure of compression from 440 to an explosion pressure of 740 pounds by the injection of the fuel. There is a loss caused by this retarding of the injection, and I am under the impression that even the Diesel, with its high pressure of compression, can and does advance the injection a few degrees ahead of the dead point without any serious increase of pressure. If the fuel injection is to be continued for 22½ degrees rotation of the cam shaft, that would mean that fuel would be fed for one-fourth of the working stroke. This is approximately what Mr. Lucas's illustration tells us. The angularity of the connecting rod will effect this by adding a little to the one-fourth of a stroke. The efficiency of an engine with such a late and prolonged fuel injection would be to approach the method of the Lanior engine. This engine was the first gas engine put on the market. The mixture was drawn in for one-half stroke and a spark passed through the mixture when the admission valve closed and expansion of the exploded charge took place on the last half of the stroke. Mr. Lucas, if he reverses the operation shown in his diagram, would better the Lanior efficiency by a good deal, but still be far short of what it should be. I have ignored one serious blunder in his diagrams, which probably is simply an oversight. He reverses all the operations of the engine. For instance, there will be an exhaust stroke and then combustion, and then the injection of the fuel followed by compression and then admission.

Mr. Lucas has told us of the possibilities of the marine oil engine. Why did he not tell us of the possibilities of the engine under light loads. Take the extreme case, an engine in a naval vessel. The present custom is to run the vessel at cruising speed. In talking with engineers I have been given to understand that this is on account of the personnel equation. I do not believe it. I feel that if mechanical stokers could be installed so that the vessels could be run at full speed without any extra wear and tear on the fireroom force, I still hold that the naval regulations would require a moderate speed for ordinary cruising and only occasional high speed runs in order to see that the machinery was kept at full efficiency.

For naval work the Wentworth engine would take in a full stroke of air at full load and the card would not vary much from the conventional so-called Diesel type. At partial load the Diesel still takes in the full allowance of air for no reason at all except to get the required temperature of compression. The Wentworth engine will cut down its air supply to fit the needs of the service. It can do this by means of preheat. Fig. 2 shows how this will work out. The Wentworth card is so drawn that it has the same load M. E. P. that the Diesel partial load does. Fig. 3 shows the effect of this upon the bearings of the engine. I assume that the main friction loss in an engine of this type or any other type is in the bearings. If this is so, the Wentworth and Diesel engine running under the same load will have a vastly different frictional loss. In the Diesel the effect on the bearings will be that which would be caused by an M. E. P. of 145 pounds per square inch on the piston, during the suction and working strokes, while the Wentworth engine under the same power will have an effect as caused by 98 pounds per square inch in the cylinder.

This is shown by plotting the pressures for each 36 degrees angle of revolution of the crank shaft. To get this result in the Wentworth engine, about two-thirds of a cylinder of air is taken into the engine and then a vacuum is created in the cylinder by the rest of the suction stroke. If the engine cylinder is 40 inches in diameter, the thermodynamic effect is that which you would get if you could compress the air in a cylinder of 34 inches diameter and expand the gases in a cylinder of 40 inches diameter. This means that for naval work and in other similar cases where full speed is not required at all times it is possible to practically compound the oil engine.

Quincy, Mass. JOHN F. WENTWORTH.

Heroic Method of Shutting Off the Bottom Blow

While running on a tug boat it became necessary to take the following heroic method of shutting off the bottom blow. While this method worked out satisfactorily in this case, it is by no means recommended as one of the best ways of closing the bottom blow.

The tug was towing three barges of sand against a stiff current with about all the power that could be developed. The boilers were priming to the extent that what might have been gained was lost by the constant throttling of the engine on account of the priming. Finally it was thought that a bottom blow of a couple of inches might steady the water in the boilers and lessen the priming.

The bottom blow consisted of a 1½-inch copper pipe with a plug cock which went directly overboard with no intermediate valve except a non-return check. A man was stationed at the valve to close it when the signal was given.

It frequently happens, as in this case, that these valves are located in inconvenient places and are quite difficult to reach, so when the signal for closing the valve was given, the valve would not close and the man's frantic endeavors were of no avail. Meanwhile the boiler had been blown down to within one inch of the bottom of the glass, consequently there was no time to spare, and it seemed that we should have to haul the fires and remain stalled in the most difficult part of the river. However, an idea came into my head which I hope will never have to come again, and picking up a square block of hard wood that lay in the fireroom and a coal maul I threw them over the guards and then went after them, shouting to the water tender to put all feed pumps on the boiler with the bottom blow open. I shoved the block along the bilges under the bottom blow pipe, which ran in a slanting position till I had the block fitted snugly between the bilges and the pipe. I sent a man out from under the boiler and made things as easy as possible for myself to get out if I had to run for it, then taking the coal maul I smashed the pipe down flat on the block and succeeded in closing the pipe together so that if it leaked any it was very little, and at least not enough to prevent us from finishing the trip successfully. When the valve was removed it was found that a piece of wood had floated into the valve and stuck there, so that it had prevented the valve from being moved one way or the other. A READER.

Marine Articles in the Engineering Press

The Cost of British and German Warships.—The recent publication of figures of the new German navy estimates affords a means for comparing the cost of the latest German and English warships. The facts brought out in this article clearly show that at the present time the capital ships of Germany are each costing from 10 to 15 percent more than the corresponding ships built in British yards. 1,250 words.—*Engineering*, Jan. 31.

The Triple Screw Channel Steamer Greenore.—The triple screw steamer *Greenore* delivered to the London & Northwestern Railway Company in July last for their Holyhead and Greenore service is the fourteenth vessel built by Messrs. Cammell, Laird & Co., Birkenhead, for the same owners, and is the first turbine steamer to be placed in the railway company's Holyhead service. The ship is 305 feet long between perpendiculars, 40 feet molded breadth, 23 feet 3 inches depth, molded to bridge deck. She is propelled by Parsons turbines constructed by Messrs. Cammell, Laird & Co., arranged on three shafts; the high-pressure turbine is on the center shaft with a low-pressure turbine on each of the wing shafts. The designed speed is 21 knots. Steam is furnished by five Babcock & Wilcox boilers. 3 illustrations. 700 words.—*The Shipbuilder*, February.

Quadruple Expansion Engines for the T. S. S. Macedonia.—The T. S. S. *Macedonia* of the National Steam Navigation Company, Ltd., of Greece, plies between Piraeus and New York. The vessel carries about 2,000 passengers and emigrants, and was constructed for a sea speed of 16 knots. The hull was built by Messrs. Sir Samuel Laing & Co., Ltd., of Sunderland, and the propelling machinery was supplied by Messrs. George Clark, Ltd., of Southwick Engine Works, Sunderland. The engines are of the four-crank quadruple expansion type, balanced on the Yarrow-Schlick-Tweedy system with cylinders 24 inches, 34½ inches, 49 inches and 71 inches diameter, with a stroke of 48 inches. The high and first intermediate-pressure cylinders are fitted with piston valves and the second intermediate and low-pressure cylinders are fitted with double ported slide valves. The engines are supplied with steam from five single-ended forced draft boilers, 17 feet mean diameter and 12 feet long, working at a pressure of 220 pounds per square inch. 2 illustrations. 400 words.—*Engineering*, Jan. 10.

Typical Ships. I. An Up-to-Date Cargo Ship.—The ship chosen as an example of an up-to-date cargo ship is the *Boeton*, built by the Central Marine Engine Works, of West Hartlepool, for the Netherland Steamship Company, of Amsterdam. She is 412 feet 6 inches long by 53 feet 6 inches beam and 29 feet 7½ inches depth. She has a gross tonnage of about 1,300, and is driven at a speed of about 13 knots by a triple expansion engine, having cylinders 28 inches, 46 inches and 77 inches diameter by 48 inches stroke, developing 3,700 indicated horsepower at 78 revolutions per minute, being supplied with steam at 180 pounds pressure by four single-ended three-furnace steel boilers operated under Howden's forced draft system. The ship is of the double decked type with a complete shelter deck and the striking point about the general arrangement lies in the fact that the whole of the crew is berthed amidships abreast of the engine casing instead of forward. While no particular original features are claimed for this vessel, or its machinery, yet it is taken as representing an economical type of cargo steamer, well built and successful in operation. While only a comparatively small number of auxiliaries are to be found in a ship of this type, yet the part they play in aiding the general economy of the machinery installation is important, as the net results in this case works out with a fuel consumption of 1.25 pounds per indicated horsepower per hour for all purposes and not for the main engines alone. Both the propelling and auxiliary machinery are described at some length. 18 illustrations. 5,000 words.—*The Engineer*, Jan. 24 and 31.

The Japanese Battleships Kawachi and Settsu.—The *Kawachi* and *Settsu* represent Japan's first attempt at dreadnought construction, the preceding battleships, the *Aki* and *Satsuma*, armed with four 12-inch and twelve 10-inch guns being now regarded as enlarged ships of the *Lord Nelson* class, although at one time they were included in tables of dreadnoughts along with the French *Dantons*. The *Kawachi* and *Settsu* are 479 feet long on the waterline, 86 feet beam, and at a draft of 28¼ feet have a displacement of 20,750 tons. They are driven by turbines of 25,500 horsepower, designed to give the ships a speed of 20.5 knots. The turbines on the *Kawachi* are of the Curtis type arranged on three shafts. On the *Settsu* there is a Parsons installation with four screws. The boilers are of the standard Miyabara type, the fuel capacity being 900 tons normal and 2,500 tons maximum. The main armament of these vessels consists of twelve 12-inch guns located in six turrets, one forward, one aft and two on each broadside, an arrangement which is severely criticised as inefficient and extravagant. There are ten 6-inch and ten 4.7-inch guns, besides five 18-inch submerged torpedo tubes. The main belt of armor extends from bow to stern and is 12 inches thick amidships and 5 inches thick at the extremities. The main turrets are protected by 9-inch armor. 2 illustrations. 1,200 words.—*The Marine Engineer and Naval Architect*, February.

The New 15,000-Ton Oil-Carrying Steamers for the Eagle Oil Transport Company.—Between July, 1911, and the date when the contracts now in hand will be completed, about 100 vessels will have been added to the world's oil-carrying fleet. Among the most noteworthy of the vessels under construction are the ten 15,000-ton oil carriers ordered by the Eagle Oil Transport Company, of London, which are to be employed for the transport of oil from the Mexican oil fields. The total number of oil tankers ordered by this company in connection with present developments is 19, including nine of 9,000 tons deadweight each, in addition to the ten already referred to. This is by far the largest order for tankers ever placed. All of them are being built under the superintendency of Messrs. Jacobs & Barringer, of London. Of the ten 15,000-ton vessels, Sir W. G. Armstrong, Whitworth & Co., Walker, and Messrs. Swan, Hunter & Wigham Richardson, Wallsend, are building three each, and Palmer's Shipbuilding & Iron Company, Jarrow, and William Doxford & Sons, Sunderland, two each. All of these vessels are generally similar except as regards details. The dimensions of Messrs. Armstrong's ships are: Length over all, 548 feet; length between perpendiculars, 530 feet; breadth extreme, 66½ feet; depth, molded, 41½ feet to shelter deck. The three vessels will be provided with propelling machinery of the quadruple expansion type by the Northeastern Marine Engineering Company, Wallsend, having cylinders 28½ inches, 41 inches, 58 inches and 84 inches diameter with a stroke of 54 inches and capable of propelling the vessels when laden with 15,000 tons deadweight at a speed 11¼ knots on a mean draft of 28 feet. Steam will be supplied by four cylindrical boilers designed for a working pressure of 220 pounds. The vessels are being built on the Isherwood system of longitudinal framing having a complete shelter deck. 3 illustrations. 1,100 words.—*The Shipbuilder*, February.

Interim Report of Committee on Boats and Davits.—A brief account is given of the findings of the departmental committee appointed to advise the Board of Trade as to the most efficient arrangements for stowing and launching lifeboats and for embarking passengers and crew, as to what extent mechanical propulsion should be adopted in such boats and as to whether rafts should be substituted in parts for boats. The committee is unanimous in recommending: (1) No limitation as to longitudinal position should be placed on the fitting of davits aft. (2) The most satisfactory arrangement is to stow an open boat attached to each set of davits. If that does not give sufficient boat accommodation, a decked boat should be stowed underneath each of a sufficient number of the open boats which are attached to davits. If this does not give sufficient accommodation the number of open boats carried may be reduced so that it may be possible to stow three decked boats under a set of davits. (3) Decked lifeboats may be stowed three in height, one above the other, under a set of davits, providing that certain conditions are complied with as to the support and means of launching the boats. (4) Further lifeboats, opened or decked, may be carried inboard immediately alongside the boats and the davits, provided that no more than six boats in two tiers of three each are so placed as to be served by one set of davits with the reservation that if it is not practicable in existing ships to fit the number of davits required no more than five boats shall be served by any one set of davits, with the reservation that if it is not practicable in existing ships to fit the number of davits required, no more than five boats shall be served by any one set of davits. When more than three boats are served by one set of davits there must be some approved means for lowering the boats in turn and rapidly. (5) In foreign-going ships in which the boat accommodation is so large that it is necessary to carry boats not actually attached to or not under other boats actually attached to davits, pontoon rafts of an approved pattern should be allowed in substitution of the above-named boats not actually attached to or not under other boats actually attached to davits, provided that the total number of persons for whom accommodation is provided in this form does not exceed 25 percent of the total number of persons the vessel is certified to carry, or the total number of persons on board, whichever is the greater. Further notes explanatory of the findings of the committee are included in this article. 1,800 words.—*Engineering*, Jan. 10.

The Brazilian Battleship Rio de Janeiro.—The design of the Brazilian battleship *Rio de Janeiro*, launched recently from the Elswick Works of Sir W. G. Armstrong, Whitworth & Co., Ltd., was evolved after two different proposals had been considered. One of the proposals was put forward by Admiral Duarte Huet de Bacellar, chief of the Brazilian Naval Commission in England, a man who has done much towards the improvement of the Brazilian navy and has naturally made a close study of the influence of tactics on ship design. The other design was by Mr. J. R. Perrett, the naval constructor of the Armstrong Company. Neither of these schemes was accepted, but a third design was ultimately evolved from the discussion of the alternative designs and the consideration of experience with the previous Brazilian dreadnoughts, the *Minas Geraes* and the *Sao Paulo*. In this article are shown plans of these three designs. Admiral Bacellar's design embodied the use of eight 16-inch guns placed in four barbettes, two of them forward and two aft, all on the centerline of the ship. In addition, six 9.4-inch guns were mounted in twin barbettes, two amidships to fire on either broadside, and two on each beam. This disposition of armament gives a broadside fire of eight 16-inch guns, four 9.4-inch guns, as well as seven 6-inch guns within an armored citadel. For ahead fire there are four 16-inch and four 9.4 inch guns and a corresponding astern fire apart from the 6-inch guns. Mr. Perrett, on the other hand, in his alternative design, held to the principle of unification of caliber, proposing either 15-inch or 16-inch guns. On account of the large caliber, the number of guns was reduced to ten, all of which were located in the turrets on the centerline of the ship, two forward and two aft, with one turret amidships, firing on either broadside. In Mr. Perrett's design the length and displacement of the ship were slightly greater than in the design submitted by Admiral Bacellar. As far as armor is concerned, there was little difference. In the *Rio de Janerio*, as now being built, fourteen 12-inch guns mounted in twin turrets on the centerline of the ship form the main armament. There are twenty 6-inch and ten 3-inch guns, besides three 21-inch torpedo tubes. The vessel is 668 feet long over all, 632 feet long between perpendiculars, 89 feet beam and 27 feet draft, with a displacement of 27,500 tons. The designed power for 22 knots is 32,000. The main broadside waterline armor is 9 inches in thickness for a length of 356 feet amidships and is continued forward and aft, being reduced in thickness first to 6 inches and ultimately to 4 inches at the extreme ends. The main belt is 13 feet 6 inches wide amidships and there are two strakes of 6-inch armor inclosing the citadel, making the total depth of the side armor amidships 28 feet. The *Rio de Janeiro* marks a distinct improvement on the *Minas Geraes* and *Sao Paulo* in respect to the distribution of armor. At the same time the under water structure has been very effectively subdivided, there being seventeen main bulkheads in addition to many subdivisions and watertight flats, making in all 365 watertight compartments. The *Rio de Janeiro* is fitted with Parsons turbines driving four shafts each with one propeller. Steam is supplied by 22 Babcock & Wilcox boilers, located in three boiler rooms, two forward and one aft. The auxiliary machinery room, as well as two magazines, separates the second and third boiler rooms. The boilers are arranged to work with oil fuel as well as coal. The coal bunkers are arranged on each side of the ships within the outer screen. Their capacity at normal draft is 1,500 tons and at full load 3,000 tons, while 500 tons of oil fuel is carried in the double bottom. The main propelling machinery is placed in three separate watertight compartments. One high-pressure ahead and one high-pressure astern turbine is placed in each wing engine room, and two low-pressure ahead turbines in which are incorporated the low-pressure astern turbines are placed in one engine room in the center of the ship between the wing engine compartments. The turbines are designed to develop at least 32,000 shaft horsepower when working at a steam pressure of 170 pounds per square inch and at about 320 revolutions per minute. The working pressure of the boilers is 250 pounds per square inch, the combined heating surface 74,800 square feet, and the grate area 2,150 square feet. The launching weight of the ship, including the cradle, was 12,400 tons. 16 illustrations. 4,600 words.—*Engineering*, Jan. 24.

Institute of Italian Naval and Mechanical Engineers.—At the recent meeting of the Italian Institute of Naval and Mechanical Engineers, General Cuniberti presented a paper on the deficiency of protection in dreadnoughts, in which he deplores the present tendency of sacrificing armor protection of battleships to the development of gun power and speed. It is the author's opinion that more attention should be given to the more thorough protection of the vital parts of the ship by using heavy armor to cover a more restricted zone than is the current practice. To spread a thickness of 12 inches of armor over more than a limited area is rendered practically impossible by the excessive displacement which would ensue, and, according to General Cuniberti, such protection would be unnecessary at the extremities of the vessel. Another paper of particular interest to naval engineers was presented by Colonel Rota on the proper placing of engines in battleships. Colonel Rota is a strong advocate of division and segregation in machinery arrangements. The hull, he insists, should be built in autonomous zones, each containing the driving apparatus with the various classes of mechanism necessary for the service of the ship. A plan of a high speed vessel was brought forward in which there are three engines and three groups of boilers, each group of boilers being dedicated to the exclusive service of its corresponding engine. Complete independence is here combined with higher efficiency on account of the shorter length of the steam pipes, while a uniformly distributed coal consumption assures constancy in the trim of the ship. To prove his point still further, Colonel Rota illustrated the application of his theory of alternate boiler and engine sections to such ships as the *Venedetto Brin*, *S. Giorgio* and *Roma* without changing the arrangement of their artillery, while other plans were presented, showing the application of his system to various other designs of battleships.

A paper on the "Standardization of Propelling Machinery in Battleships," by Captain Fea, emphasized the enormous wastes which are occurring in the attempt to utilize so many different types of boilers, engines and auxiliaries for ships of similar designs and types. The evils of the present system are only too evident, as this great variety of types increases to an immense extent the difficulty and cost of repairs and changes which are continually necessary. In the matter of boilers only two countries have set a straight course for themselves, and compel manufacturers to follow in the search for a uniform and practically perfect steam generator. These two—Germany and Austria—have settled on standard types of boilers, Germany choosing the Schultz and the Austrians the Yarrow type. In general, two types of boilers have emerged to-day from the phalanx of theories and failures; these are the Yarrow, or Odero-Blechynden, with three drums and almost vertical tubes, and the Babcock & Wilcox, with single drum and tubes almost horizontal. Both of these types possess the following advantages indispensable to navy boilers: simplicity of construction and working, and elasticity in working and high thermal efficiency. The author has strongly urged the adoption of a universal type of boiler common to both battleships and torpedo boats. The American plan of using horizontal tube boilers on large ships and vertical tube boilers on the torpedo fleet seems to him inferior to the German method of adopting for every type of ship a uniform type of boiler with tubes all of equal diameter and thickness. Captain Fea also brought up the question of pushing unification still further so as to obtain a single boiler which should represent an element common to the generating plant of any ship. The author then proceeded to discuss the application of his scheme to turbines. The most suitable turbine for warships was without question working on a mixed system with impulse in the high-pressure and reaction in the low-pressure. The advantages of the mixed type of turbine include good thermal efficiency, extreme simplicity, distribution of the engine over two or three shafts, small space occupied and adaptability to any type of vessel. It is also suggested that eventually a standard type of turbine might be developed long these lines which would be suitable for all battleships.

A paper of exceptional importance, on account of the tangible results obtained by the author, was the description by Major Nino Pecoraro of the experiments conducted by himself and Cav. Peragallo during the last year in the Froude basin at the Spezia Arsenal, with a view to defining and tabulating the action of the Frahm anti-rolling tank. The experiments may be divided into two groups: (1) Experiments on models with a view to ascertaining the action of the tanks in calm weather. (2) Experiments with the navipendulum for the same purpose in a rough sea. In the first experiments the water in the tanks was carefully noted: The variation of opening for the passage of water and air; the period of oscillation of the ship; the volume of water in the tanks and the position of the tanks. The investigation was most thorough and the results are presented in this article most clearly with the aid of diagrams and tables. The second series of experiments with the navipendulum were to determine the conditions of rolling in a ship with or without bilge keels and tanks, and were made on the basis of a system of waves whose lengths and periods were gradually increased and whose height and length were proportioned according to the laws usually observed in nature. The efficiency of Frahm tanks was conclusively proved by the above experiments, which had also demonstrated that this efficiency was extremely high when approaching the critical conditions of synchronism, under which conditions it seemed considerably superior to that of rolling keels of the largest dimensions possible in practice. 30 illustrations. 12,400 words.—*The Engineer*, Jan. 24 and 31 and Feb. 7.

The Curtis Turbines of the Scouts Marsala and Mino Bixio.—By Commr.-Ingr. Vittorio Malfatti. The title of this article implies simply that a description of the Curtis turbines for the two scouts named is given. Nevertheless, the article contains a very complete resumé of the application of Curtis turbines to warship propulsion. Particulars are given of almost every Curtis turbine installation which has been made on the naval vessels of any nation. The first application was that on the United States scout cruiser *Salem*, where the turbines developed 16,000 shaft horsepower at 350 revolutions. The next installation in the United States navy was on the battleship *North Dakota*, where two turbines were fitted, each designed to develop 12,500 shaft horsepower at 245 revolutions. The *North Dakota* was followed in the course of about a year by the three destroyers, the *Sterret, Perkins* and *Walke*, each of which was fitted with two Curtis turbines. Those of the *Sterrett* developed 12,789 shaft horsepower on trial at a speed of 631 revolutions. The other two boats gave similar results. This constituted the first application of Curtis turbines to small warships, and they were characterized by a comparatively small diameter and by a high speed. A further application was that on the United States destroyer *Henley*, where two Curtis turbines were installed, each designed to develop 5,500 shaft horsepower at 585 revolutions. These turbines were installed in conjunction with combined reciprocating engines connected to the turbine shafts by means of jaw clutches. A similar arrangement has been selected for two of the eight destroyers recently ordered by the United States navy. In the United States battleship *Nevada* two Curtis turbines are to be installed, developing a total of 26,500 shaft horsepower. The Japanese navy have in use at the present time Curtis turbines totalling 210,000 shaft horsepower. The Argentine dreadnoughts *Rivadavia* and *Moreno* are each fitted with three Curtis turbines developing together 45,000 shaft horsepower at a speed of 275 revolutions. The Italian scouts *Marsala* and *Mino Bixio*, which form the subject of this paper, are 431 feet long between perpendiculars, 42 feet 9 inches mean breadth, 13 feet 7 inches mean draft, 3,575 tons corresponding displacement, 22,500 shaft horsepower, 28 knots designed speed. A detailed description is given of the turbine engines for these ships. 2 illustrations. 3,200 words.—*Engineering*, Jan. 31.

H. M. Submarine Boat E-4.—An explanatory note containing meager details of the submarine boat E-4 is published in conjunction with two excellent photographs of the boat taken during a surface run. It is understood that the boat is 180 feet long, close upon 23 feet beam, having a submerged displacement approximating 800 tons. The surface speed of the vessel is about 16 knots, the heavy oil engines with which it is fitted having a brake horsepower of over 1,500. The boat is constructed by Messrs. Vickers, Ltd., Barrow-in-Furness. 2 illustrations. 170 words.—*Engineering*, Jan. 10.

New Books for the Marine Engineer's Library

Calculations for Marine Engineers

REVIEWED BY PROFESSOR HERBERT C. SADLER*

Calculations for Marine Engineers (being Part I of Griffin's *New Guide to the Examinations for Marine Engineers*). By R. A. McMillan, B. Sc., Wh. Ex. Size, 5½ by 8⅜ inches. Pages, 336. Illustrations, 3. London, 1912: Charles Griffin & Co., Ltd. Philadelphia, 1912: J. B. Lippincott Company. Price, $3 net.

Within the past decade there has been a steady increase in the amount of scientific knowledge demanded of the seagoing engineer, and the object of the present book is to cover, in detail, the various problems relating to marine engineering which form the basis for the British Board of Trade examinations for first and second class engineer's certificates. The volume forms Part I of the complete work, Part II of which will appear later. The book is divided into sections representing the scope of the examination questions, and includes the following: (1) General arithmetic. (2) Mensuration. (3) Problems relating to steam, heat, etc. (4) Some general calculations relating to marine engine operation. (5) Mechanics.

In the first two sections the author has very wisely chosen problems in arithmetic and mensuration from those which bear directly upon marine work. The money and practice computations are, however, entirely in English units. The problems in heat, steam, combustion, horsepower, etc., are well arranged and cover the field of knowledge required by the seagoing engineer very thoroughly. The fourth section contains a somewhat varied collection of calculations ranging from the pressure upon a crank pin to the computations for propellers, salinometers and displacement of ships. The part devoted to the engine itself in this section is somewhat meager and might better have been placed in the second section, where, under the head of Mechanics, the design of some of the principal parts is discussed. The section dealing with boilers and riveted joints is well illustrated by numerous problems, and the appendix contains several examination papers and questions, reference being made in each case to certain parts of the text which will help in the solution of the same.

The principal criticism that can be made of the book is in connection with the arithmetical work and results of the various problems. The author has carried out every answer to a degree of accuracy (?) which can only be designated as absurd. When one considers the data upon which many of the problems are based, and which in all probability do not come within one or two percent of the truth (in some cases even more), the absurdity of carrying out the result to one ten-thousandth of 1 percent is evident. The labor involved is entirely wasted, particularly as most of the problems are of an eminently practical nature. Such examples lead to a wrong conception of what accuracy really is. Perhaps the most glaring case occurs on page 177, where the student is told to divide 1194.22771776 by 1870.22771776, in a problem which relates to propellers—of all things! One or two other examples may be given as illustrations: Page 55, percentage of ash obtained by weighing ashes in baskets, 4.47704 percent; Page 89, capacity of a cask, 52.26875 gallons; Page 95, weight on a safety valve, 382.0978854 pounds; also see Page 269; horsepower, Page 136, 674.25018; Page 165, length of ship, 206.1334 feet.

It is to be hoped that in future editions the author will ruthlessly draw his pencil through all figures beyond the first or second decimal place, as it is hardly conceivable that a practical engineer, or even a trained experimenter with the most delicate apparatus available, would be certain of measuring to one part in four thousand million.

It is also a pity in these days of the decimal system that the author helped to perpetuate the cumbersome units of tons, hundredweights, quarter pounds, and sometimes decimals of a pound, when tons and decimals of a ton are amply sufficient, particularly, for example, in making *an estimate* of the amount of coal in a bunker.

Perhaps, however, the author is not to blame for the above if such things are insisted upon by the Board of Trade Examiners; but if the latter are at fault, the sooner attention is called to such a state of affairs the better.

On the whole, however, the work should prove of great assistance to engineers studying for the various certificates. The numerous problems throughout the work and in the appendix cover the ground very satisfactorily, and in nearly all cases the various steps in the solutions are clearly stated and easy to follow.

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The Navy League Annual

The Navy League Annual. Sixth Edition. Edited by Alan H. Burgoyne, M. P. Size, 5½ by 8½ inches. Pages, 392. Numerous illustrations. London, 1912: John Murray. Price, 5s. net.

The present volume is the sixth year of issue of the *Navy League Annual*. As pointed out by the editor in the Foreword, the past year has witnessed a noteworthy progress in naval develpoment. The size of battleships has increased, in one case at least, beyond 30,000 tons. Fuel oil has become an important factor in all armored vessels. Triple gun turrets are in some ships replacing the old two-gun turret arrangement. Destroyers have increased in size to over 1,000 tons, and seagoing submarines with a surface speed of 20 knots have been developed. Furthermore, a new element has been introduced in naval warfare, and that is the conquest of the air. To deal with such a complicated problem as the analysis of naval development under such circumstances, the editor has chosen wisely in securing the aid of specialists for discussing the different subjects which enter into the problem.

The book is divided into three parts. Part I contains, first, a chapter on the progress of the British navy. Then comes a chapter on the progress of foreign navies, and finally a chapter on comparative naval strength and a short glossary of common naval terms. Part II contains nine articles on special subjects, contributed by persons closely identified with the special subjects treated. In the first chapter of Part II, for instance, the position of Great Britain in the Mediterranean is discussed by Mr. George Lloyd, M. P., whose wide knowledge of international politics enables him to present with authority one of the most urgent national problems of the day. Other articles by Mr. Gerard Fiennes, Mr. Hector Bywater and Mr. Jean B. Gattreau deal with such subjects as Imperial Strategy, The Future of the French Navy and German Naval Progress. There are also contributions from Mrs. Richard Longland, Capt. Stanley W. Beeman and Marteau, but the two articles which are of special interest to engineers in this part of the book are the one on Recent Progress in Naval and Marine Engineering, by W. Stoddart, editor of the *Naval Engineer Review*, and that on the Development of Ship-Type, by the editor of the *Annual*.

The article on Recent Progress in Naval and Marine Engineering is disappointing, in that it deals not so much with progress in the last few years as with the entire progress of naval and marine engineering since steam was introduced as a means of propulsion in marine work. The article is therefore rather a résumé of what is common knowledge to practically every marine engineer, and is of interest chiefly to the layman rather than of value to the engineer.

The article on the Development of Ship-Type is of interest chiefly because it deals with a subject which is uppermost in the minds of naval architects and naval constructors. The author compares the development of ship-types in the building up of the present British navy, and points out the serious errors which were made by the Admiralty, as well as the directions in which valuable progress has been made. The author's idea seems to be not to develop the navy in a homogeneous and logically progressive series of units, so that the newer ships can be utilized in harmony with the older vessels, but to progress by leaps and bounds at every opportunity by producing a ship-type embodying all the valuable features of every type now in use into one single unit, regardless of cost or feasibility. The items which he would include in a proposed design are the highest speed, the most powerful armament and the heaviest armor that can be found anywhere afloat, regardless of the size of the vessel, the power required to drive her, or the expense necessary for her production. It seems to us that there are too many variants in the problem to admit of its treatment in such a summary manner, without considering the effect of every factor which enters into the problem. There is no doubt that the prime necessity of a capital ship is the most powerful armament that can be obtained together with adequate protection, but the necessity of extreme speed is at least a matter for debate, not to mention many of the other doubtful factors.

Part III contains 84 pages of tables showing the evolution of various ship-types and comparative tables of contemporary naval vessels of all classes. The tables are ingeniously arranged and are useful in comparing the naval strength of various nations.

List of Shipping

Bureau Veritas, 1912-1913, Repertoire General. Two volumes. Size, 10½ by 11 inches. Pages, steamers, 1,165; sailing vessels, 946. Paris, 1912: 8 Place de la Bourse, or London, E. C., 155 Fenchurch street. Price, complete, £3 3s. ($15); steamers, £1 15s.; sailing vessels, £1 10s.

This is the forty-third edition of the general list of merchant shipping of all nations issued annually by the Bureau Veritas. It is one of the most complete compilations of such statistics published. The general list contains the names of the vessels and their masters, the class, signals, rig, flag, tonnage, length, beam, depth, the name of the builders and date of building, the principal details of the propelling machinery, the name and residence of the owners and the ports of registry. The names of the vessels are arranged alphabetically, and in the list of steamers are included all motor vessels. In addition to the general list the volume devoted to steamers contains general statistics of each flag, statistics of steamers built, bought and sold in the principal countries during the year, a list of steamships of all nations, tables of changes of names, new steamers, etc., a list of steamers carrying petroleum in bulk, a list of cable vessels, an alphabetical list of iron and steel shipbuilders, arranged according to the nationality, an alphabetical list of steamship owners, arranged according to the nationality, with the names and gross tonnages of their steamers, and a list of all drydocks, etc., in all parts of the world. The volume devoted to sailing vessels is arranged in practically the same manner as that for merchant steamers, except that there are separate lists for the owners of wooden vessels and for the owners of iron vessels and a list of vessels with auxiliary engines.

Personal

Naval Constructor R. H. M. Robinson, U. S. N., has resigned from the navy to accept an important position with the Lake Torpedo Boat Company, Bridgeport, Conn.

George A. Dean, Jr., formerly superintendent of the E. J. Codd Company, Baltimore, Md., has resigned to become general superintendent of the Spedden Shipbuilding Company, of Baltimore.

H. Matteson, formerly of Matteson & Drake, is now associated with Cox & Stevens, naval architects, marine engineers and vessel brokers, 15 William street, New York City. Mr. Matteson is in charge of the commercial vessel brokerage department of this firm.

George B. Drake, naval architect, 17 Battery Place, New York City, has been appointed assistant manager of the marine department of the Texas Company, New York. A large part of Mr. Drake's private practice, which relates especially to the design of oil-tank steamers, barges and towboats, as well as vessels for both passenger and freight service, will be taken over by Martin G. Kindlund, naval architect and engineer, at the same address.

Changes in the personnel at the Newport News Shipbuilding and Dry Dock Company, Newport News, Va., were announced recently as follows: F. P. Palen to be assistant general manager of the company; J. B. Weaver to be general superintendent of construction; J. W. Gray, assistant to the general manager; W. H. Benson, superintendent of hull construction; Neils Christiansen, superintendent of machinery; J. H. Lofland, assistant superintendent of hull construction. This order means a distinct promotion for each of those named and is now in effect.

Alec McNab, of the McNab Company, Bridgeport, Conn., sailed for Europe recently to look after the business interests of this company abroad.

William B. Dickson, recently one of the vice-presidents of the United States Steel Corporation, has been elected president of the International Steam Pump Company, succeeding the late Benjamin Guggenheim, who went down on the *Titanic*.

F. H. Allison has been appointed general purchasing agent, in charge of all office and factory supplies for the American Vanadium Company and the Flannery Bolt Company, Pittsburg, Pa.

Norman L. Snow has been appointed general sales manager of the Terry Steam Turbine Company, with headquarters at the home office of the company at Hartford, Conn. The New York district office of this company, at 90 West street, New York City, will continue, as heretofore, under the management of Frederick D. Herbert.

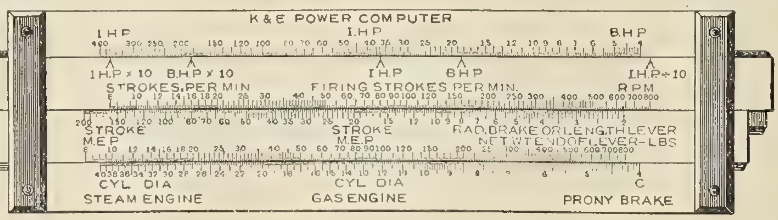
Obituary

John Fritz, one of the best-known mechanical engineers in the United States, died at Bethlehem, Pa., Feb. 13, at the age of 90 years. Mr. Fritz, familiarly known in the engineering profession as "Uncle John," was born Aug. 21, 1822, in Londonderry Township, Chester County, Pa. At the age of 16 he entered the mechanical field as an apprentice, and rapidly exhibited remarkable ability in the development of the iron industry. His first achievements were of a revolutionary character in the methods of making iron rails. Then he introduced important improvements in blast furnace practice. In 1860 he became general superintendent and chief engineer of the Bethlehem Iron Company, and in this capacity he turned his attention to perfecting the Bessemer process of making steel and improving the Siemens-Martin open-hearth process, as well as the design of rolling mills for plate and structural shapes. He was the originator of the method for manufacturing solid steel armor plate for naval construction. He was a member of all the principal engineering societies in this country and abroad, and was honored by many of the scientific societies of the world.

ENGINEERING SPECIALTIES

Power Computing Slide Rule

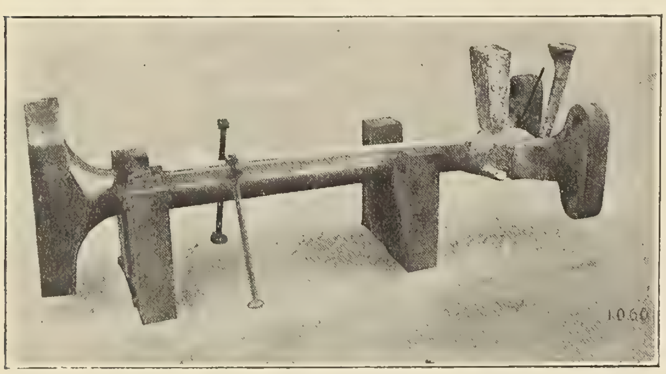
Keuffel & Esser Company, Hoboken, N. J., have recently developed a new slide rule for computing the power and dimensions of steam, gas and oil engines. The construction of the power computing slide rule is similar to that of the well-known Duplex slide manufactured by this company. The face of the rule, as shown in the illustration, carries five series of special



graduations to be used in determining brake horsepower, indicated horsepower, or principal dimensions of steam, gas and oil engines of any size. On the reverse face of the rule are engraved the *A*, *B*, *C* and *D* scales usually found on the Mannheim slide rule. The new rule measures 7½ inches by 2 inches, making it of convenient pocket size.

Unusual Quick Repair of a Connecting Rod on the Clyde Liner Iroquois Executed by the Thermit Process

A repair unique for despatch was executed for the Clyde Line last December when the connecting rod of one of the main engines of the *Iroquois* broke while the vessel was at sea. A wireless message was sent to the general offices of the company, and they immediately communicated with the Goldschmidt Thermit Company and arranged for a representative to meet the steamer upon her arrival. The steamer reached her pier at 11 P. M. Dec. 24, and the connecting rod was immediately removed, placed on a truck and taken down to the Jersey City repair shops of the Goldschmidt Thermit Com-



pany. Work was immediately started to prepare the broken piece for welding. To do this, part of it had to be cut away along the line of fracture so as to provide a space about one inch wide for thermit steel to flow into. The parts were then lined up and surrounded by a mold which provided for a reinforcement or collar all around the broken parts which was later to be filled with steel from the thermit reaction. This mold was completed early Christmas morning and the operation of preheating commenced. This was done with a compressed air gasolene (petrol) torch, which brought the broken sections inside of the mold to a bright red heat, at which time the charge of thermit was ignited in the crucible suspended over the pouring gate of the mold. The thermit reaction produces liquid steel in half a minute, and this steel being twice as hot as ordinary molten steel, will melt the metal that it comes in contact with and amalgamate with it to form a single homogeneous mass. In this repair, therefore, the thermit steel was tapped into the mold, where it amalgamated with the metal of the connecting rod and the whole cooled down into one solid piece.

As stated above, this work was completed on Christmas day and the rod was allowed to cool over night. On the morning of Dec. 26 the mold was dismantled, the weld trimmed up and the rod returned to the steamer. She was due to sail early in the afternoon of the 26th, and could have done so had she not been held up a few hours on account of cargo. No delay at all was occasioned by the repair of the connecting rod.

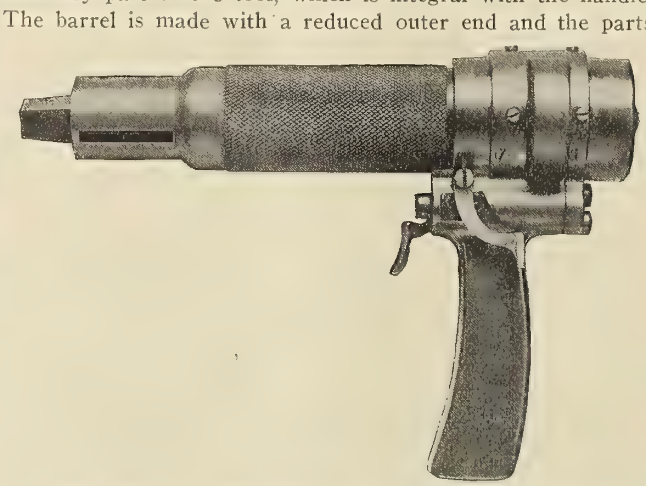
It may be of interest to our readers to know that two vessels of the Clyde Line, the *Apache* and the *Arapahoe*, have thermit welds on their stern frames. The *Apache* was welded July, 1905, and the *Arapahoe* in June, 1909.

The thermit process offers many advantages for repairs of this character, owing to the fact that the sections can be welded without their removal from the vessel and without keeping the vessel in drydock more than two or three days at the most. The saving in drydock charges is a very large item, and the fact that the vessel can be so quickly restored to service is another great advantage.

Condenser Packing Tool

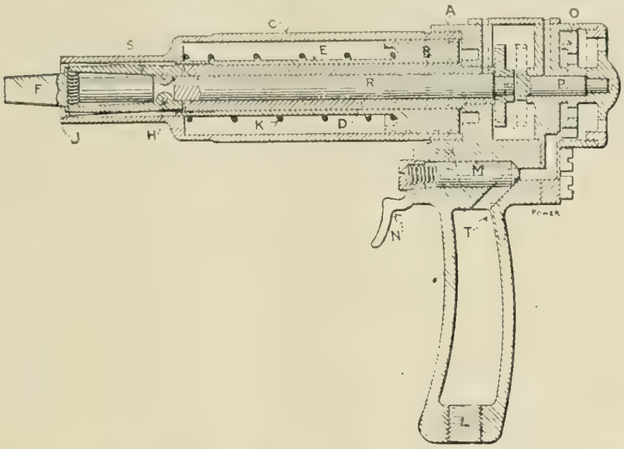
H. G. Kotten Company, New York, has on the market a condenser packing tool which is operated by compressed air and is so designed that it winds the packing cord around a spindle and then pushes it into position around the condenser tube when the operator presses a finger and a thumb trigger, which control the two operations.

In the sectional view of the device shown, *A* represents the body part of the tool, which is integral with the handle. The barrel is made with a reduced outer end and the parts



are secured by screw threads, as shown. The tubular reciprocating plunger *E* is provided with a piston *B* which accurately fits within the barrel *C*. A rotary shaft fits within the inner guide tube and is provided with an enlarged journal bearing at its outer end. The end of this enlarged part is turned down into the form of a frustum of a cone, as indicated at *F*, and is provided with a shoulder which fits against the end of the tubes around which the packing is to be inserted. This enlarged part also constitutes a cylinder around which the packing cord is wound before the tool is put into use. To secure this cord a longitudinal groove is provided in the body part in which is pivoted upon a pin H a longitudinal finger J. It is grooved at its outer end and has a spiral spring inserted in a hole, the arrangement being such that normally this finger is held at its outer end against the inner face of the small end of the barrel. The spiral spring K is for the purpose of returning the reciprocating plunger to its normal position after it has been actuated by the compressed air.

A longitudinal slot to the small end of the barrel constitutes an opening for the insertion of the packing cord. The air supply is conducted to the handle of the tube through a rubber



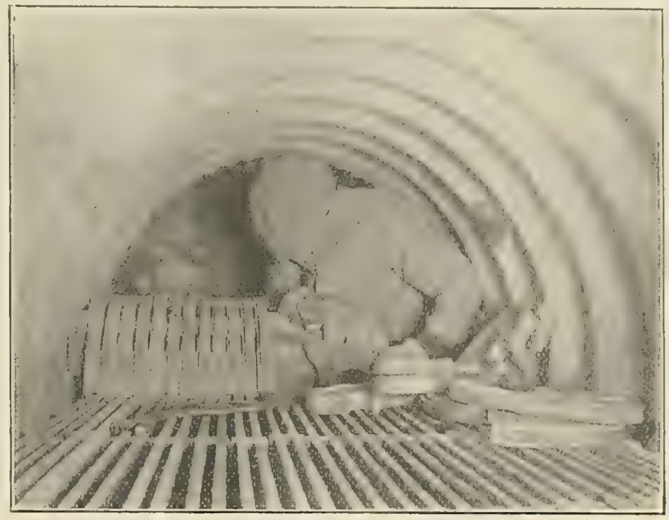
tube. In the bottom of the handle is an opening L, which runs to the body of the valve, where it is divided into two channels, one conveying the compressed air to the piston and the other to the driving motor. The valve M is held in a seated position by a spiral spring, and the valve is actuated by means of the trigger N.

The operative part of a rotary motor is shown at O. It is secured to the rear end of the breech of the tool and the shaft P actuates the rotating shaft R of the tool. A detachable cap is secured to the casing of the motor and is provided with a journal bearing. A pinion carried by the shaft P meshes with the gear wheel, which rotates on a bearing journal that is secured to the breech. Another pinion is carried by a shaft integral with the gear wheel and meshes with a gear wheel that is secured to the rotary shaft R. A second valve is kept seated by the pressure of a spring in the channel running to the rotor of the motor. This valve is operated by the lever T, which is worked by the pressure of the thumb. Air vents are provided for liberating the air after it has passed through the motor.

When using the tool one end of the cord is inserted at the outer end of the slot shown at the small end of the barrel. Air pressure is immediately admitted to the motor by merely pressing a trigger with the thumb. The motor rotates the spindle S, thereby drawing the cord through the opening and winding it around the spindle. The cord is then in a position to be forced on the tube end by the reciprocating plunger. The operator presses the finger trigger a number of times in succession until the cord has been driven home, the number of blows depending upon the density to be given to the packing. In this way the operator passes from one tube to another in quick succession. The average operator can easily pack a condenser at the rate of from 10 to 15 tubes per minute.

Wager Patent Improved Furnace Bridge Wall

An improved furnace bridge wall, which has been installed with satisfactory results on ocean-going and harbor tugs, ferryboats and by many of the large railroads and steamship companies, is made by Robert H. Wager, 100 William street, New York. This device was designed to provide at a very moderate cost a bridge wall which can be easily removed and replaced without sacrificing material. It is composed of gray cast iron bars with suitable air openings between. The back bridge wall casting is provided with suitable air openings to admit air freely from the ash pit to and around the bridge wall castings, and through openings in the bridge wall bars to the fire, in order to do away with the usual pile of dead fire against the bridge wall. The intermediate sections have formed at the crest of the bridge a series of openings by which air is admitted to mingle with the gases from the furnace as they pass into the combustion chamber, thus effecting their complete combustion and preventing gasing and excessive

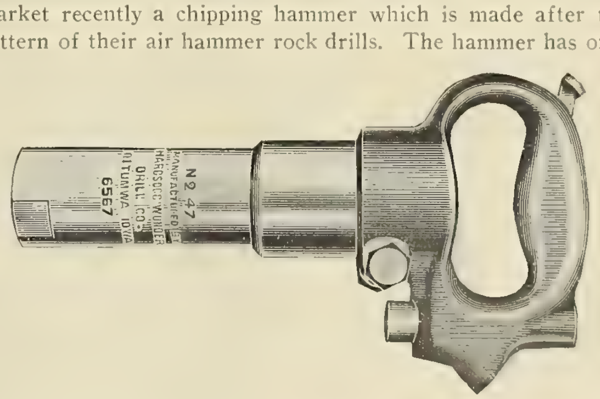


smoking. When in use the bars of the bridge are securely locked in place, but they are provided with means for readily removing them when necessary.

The illustration shows how easily the Wager improved bridge wall may be attached or detached to the bridge wall casting, whereby a single bar may be removed from any part of the bridge wall without disturbing the general assembly.

"Wonder" Chipping, Beading and Calking Hammer

The Hardsocg Wonder Drill Company, Ottumwa, Ia., manufacturers of "Wonder" rock drills, have placed on the market recently a chipping hammer which is made after the pattern of their air hammer rock drills. The hammer has only



one movable part; that is, a combined piston, valve and hammer. The particular advantage claimed for this hammer is that there is no live air used in returning the piston on the return stroke, and consequently there is a great saving in the air consumed over the old-style valve hammer. The hammers are made in three sizes, of 8, 10 and 12 pounds, respectively. The 8-pound hammer is suitable for calking 3/16-material, while the 10 and 12-pound hammers are for heavier work in proportion. They are made with either outside or inside latch.

SELECTED MARINE PATENTS

The publication in this column of a patent specification does not necessarily imply editorial commendation.

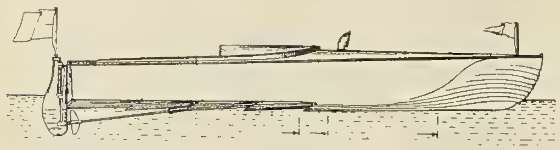
American patents compiled by Delbert H. Decker, Esq., registered patent attorney, Loan & Trust Building, Washington, D. C.

1,041,849. MOTOR BOAT. CHARLES H. MYERS, OF BUFFALO, N. Y.

Claim 2.—The combination of a boat including an upper main hull, and a lower auxiliary hull, and an approximately oblong skimming device rigidly connected with the boat and composed of a continuous series of detachable buoyant sections adapted to be floated into position and assembled one at a time. Nine claims.

1,050,517. HYDROPLANE BOAT. IRWIN CHASE, OF BAYONNE, N. J., ASSIGNOR TO ELECTRIC LAUNCH COMPANY, OF BAYONNE, N. J., A CORPORATION OF NEW JERSEY.

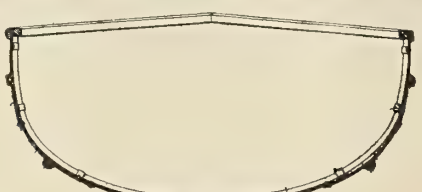
Claim 1.—A boat provided with a surface-skimming hydroplane having



a keelwise corrugated under surface devoid of transverse obstructions. Thirteen claims.

1,050,480. METALLIC BOAT CONSTRUCTION. ANDREAS P. LUNDIN AND EINAR L. M. SIVARD, OF NEW YORK, N. Y., ASSIGNORS, BY MESNE ASSIGNMENTS, TO ASTOR TRUST COMPANY, TRUSTEE, A CORPORATION OF NEW YORK.

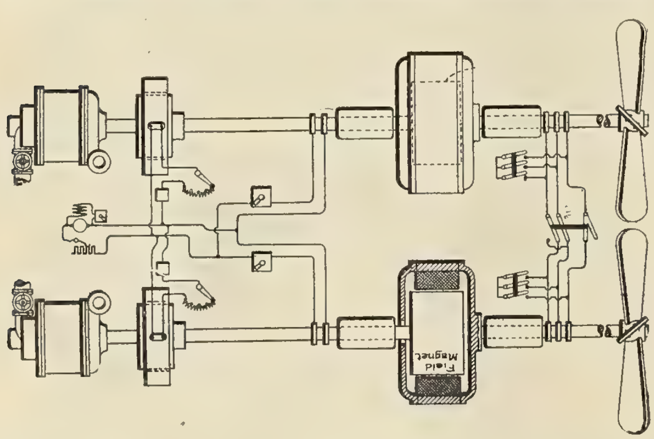
Claim 1.—In metallic boat construction, the combination with an outer metallic plating having a semi-circular groove depressed below its inner



surface at the longitudinal center line of the boat, and a pipe within such groove. Six claims.

1,047,858. TURBO-ELECTRIC PROPULSION OF VESSELS. ELIHU THOMSON, OF SWAMPSCOTT, MASS., ASSIGNOR TO GENERAL ELECTRIC COMPANY, A CORPORATION OF NEW YORK.

Claim 2.—In a system of ship propulsion, the combination with a pair of turbines, of revolving field magnets each driven by its respective turbine, a revoluble armature structure concentric with each field magnet, screw propellers each having a shaft carrying its respective armature



structure, an exciter supplying current to said field magnet windings, polyphase windings on said armatures, means for interconnecting the same, and means for holding stationary either of said revolving field magnets. Four claims.

1,043,915. APPARATUS FOR SUPPORTING AND LOWERING LIFE-BOATS. JOHN E. ERICKSON, OF CHICAGO, ILL.

Claim 1.—A device of the class described comprising two spaced supporting rails; a boat arranged between said rails and having studs at its ends resting upon said rails; means engaging said studs for moving said boat longitudinally of said rails; and boat-lowering means at the terminals of said rails. Twelve claims.

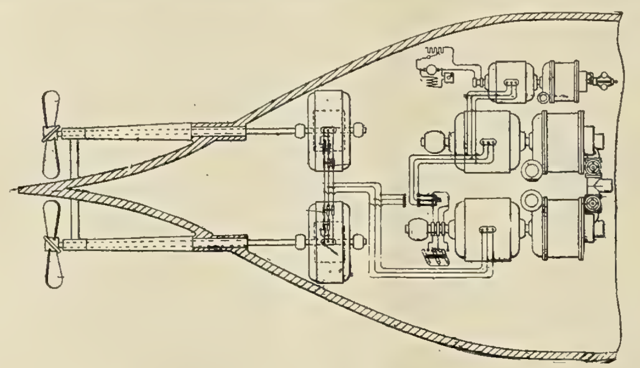
British patents compiled by G. F. Redfern & Company, chartered patent agents and engineers, 15 South street, Finsbury, E. C., and 10 Gray's Inn Place, W. C., London.

14,962. BOAT RAISING AND LOWERING GEAR. P. R. ARNOTT, WESTCLIFF-ON-SEA.

This invention relates to davits, and consists in adapting a centrally disposed stanchion to serve as a stop for the boat when in-board. The davits, strengthened by members, are pivoted and are splayed to give an initial tendency to swing outwards. The falls are led from the boat hooks over pulleys to a winch provided with a foot brake. The pulleys are secured to a stanchion having a lipped plate which stops the boat. The inner chocks are secured to the davit members, while the outer ones are pivoted to the davits and are provided with tail-pieces which co-operate with fixed stanchions, whereby the chock is automatically brought into position and released as the boat is being either raised or launched.

28,512. IMPROVEMENTS IN SHIP PROPULSION. THE BRITISH THOMSON-HOUSTON COMPANY, LTD., CANNON STREET, E. C.

This invention relates to the propulsion of vessels by means of electric motors supplied with current from electric generators driven by high-speed economy turbine engines, the object being to take advantage of the economy of space, material and steam and to control the speed while preserving the high economical speeed of the prime mover. In the system of propulsion high-speed economy steam turbines drive polyphase



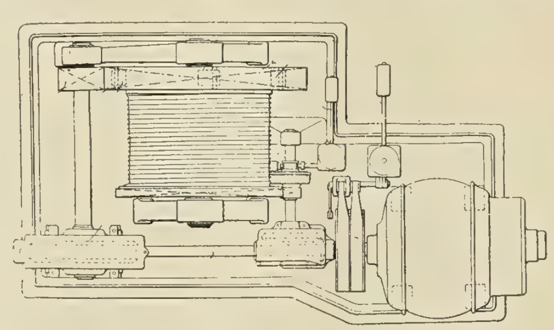
generators of the induction type supplying current to propelling induction motors, an auxiliary synchronous generator being connected to the stators of the generators for setting the phases, a variable speed turbine being provided for driving the auxiliary generator. The switches for short-circuiting the winding of the rotor of the generator and the double throw-over switch connecting either the slip rings or the leads, serve for connecting the main generator in parallel to the motors, and for connecting the main generators in concatenation.

26,983. IMPROVEMENTS IN ANCHORS. A. E. GILBERT, TOTTERIDGE, HERTS.

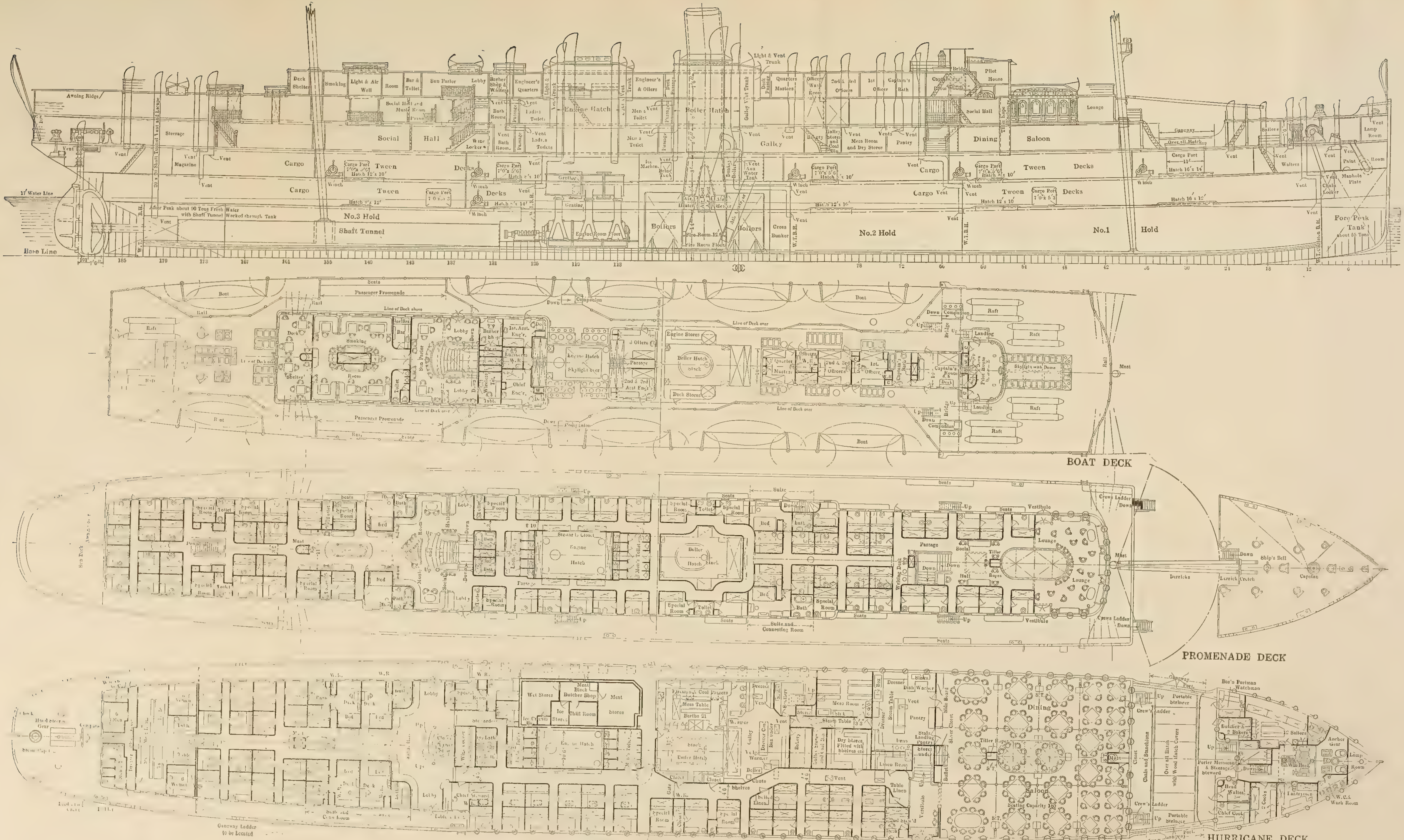
A stockless anchor having pivoted detachable arms constructed according to this invention, comprises a block to form the middle portion of the crown, and which carries opposite integral trunnions and elongated stop portions to engage the borings, the anchor arms, each formed with the counterparts of the trunnions and elongated portions, a shank being detachably fitted to the block within the double bore, and a coupling yoke is detachably connected to the anchor arms.

12,761. ELECTRIC BOAT HOISTS. SIR W. G. ARMSTRONG, WHITWORTH & CO., LTD., AND R. WRIGHT, ALL OF ELSWICK WORKS, NEWCASTLE-UPON-TYNE.

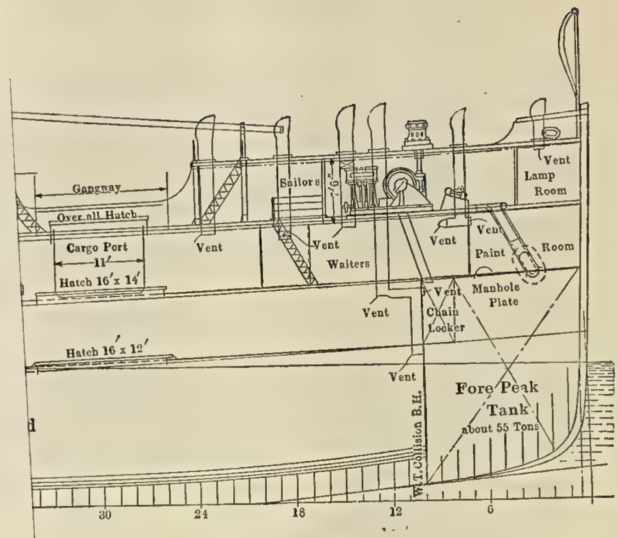
The following apparatus is designed to keep the slings taut as the boat rises and falls on the waves. The hoisting drum is driven from the motor through a shaft, worm pinion and ring pinion, the latter having pawls engaging ratchet teeth on the drum. The shaft, which is braked by bands, also drives through bevel gears a shaft on which is a

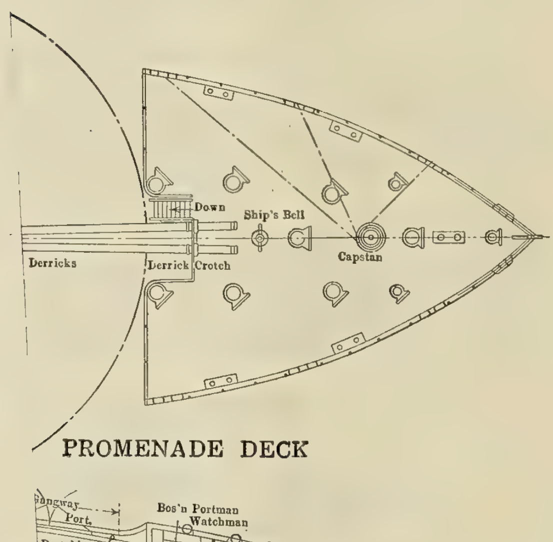


friction clutch. The clutch is normally held out by a weighted arm, which can be raised by a solenoid connected to the lifting and lowering controller. When lifting the pawls drive the drum, the clutch being out. When the controller is reversed, however, the ring is reversed and the drum can therefore rotate under the pull of the slings, but as the solenoid has put the clutch in, the motor is tending to drive the drum the reverse way, but only with a force small enough to be overcome when lowering the boat, but sufficient to hold the slings taut as soon as the boat is water-borne.

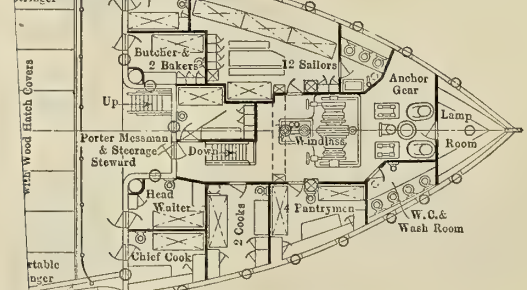


PROFILE AND DECK PLANS OF CLYDE LINER LENAPE





PROMENADE DECK



HURRICANE DECK

International Marine Engineering

Published Monthly by ALDRICH PUBLISHING CO.

17 BATTERY PLACE, NEW YORK — 31 CHRISTOPHER ST., LONDON, E. C.

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Vol. XVIII — APRIL, 1913 — No. 4

The Clyde Line Coastwise Steamship Lenape

A noteworthy addition to the American coastwise fleet is the steamship *Lenape,* built recently for the Clyde Steamship Company, New York, by the Newport News Shipbuilding & Dry Dock Company, Newport News, Va., under the supervision of and from designs prepared by Theodore E. Ferris, naval architect and engineer, New York, in collaboration with H. H. Raymond, vice-president and general manager of the Clyde Steamship Company. The vessel was built under special survey for classification by the American Bureau of Shipping to Class A-1 for twenty years for coastwise service. The principal dimensions of the vessel are as follows:

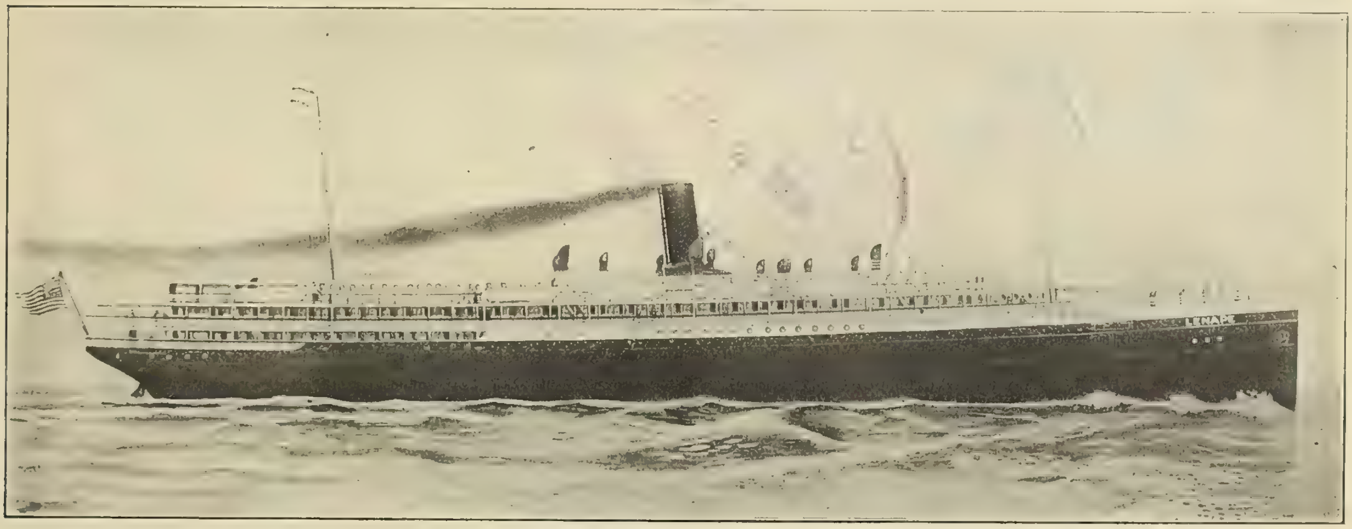


FIG. 1.—THE NEW CLYDE LINER

	Feet
Length from fore side of stem to after side of rudder post	383
Length over all	397
Beam, molded	50
Depth, molded to hurricane deck	30
Depth, molded to main deck	22
Load draft	17

Hull Construction

The *Lenape* is a hurricane-deck type vessel with a single bottom. The hull is divided by five watertight transverse bulkheads into six watertight compartments, including three cargo holds and the machinery space. The general arrangement and type of construction are shown in the 'midship section and plans of the ship. Both the lower and the main decks are complete steel decks; the hurricane deck is partly of steel sheathed with Oregon pine and thoroughly calked. A new feature for American coastwise ships is the inclosed bridge amidships.

As can be seen from the plans, the vessel has a raised forecastle head, the side steel structure of the ship is carried up to the promenade deck. The deck-house, aft of the bridge inclosure, is also of steel. The house above, however, on the promenade deck is of wood, and the pilot house, officers' quarters, the house containing the sun parlor, smoking room and deck shelter are also of wood, and are located on a wood deck.

The entire hull below the hurricane deck, except for the space required for the propelling machinery and coal bunkers, is devoted entirely to cargo. The whole space available for cargo amounts to 295,000 cubic feet, giving the vessel a deadweight cargo capacity on a 17-foot draft of 2,700 tons. On this draft the ship has a displacement of 6,250 tons.

The *Lenape* has side cargo ports at the upper and lower 'tween decks, as shown on the plans, and also cargo hatches as shown. For handling cargo the forward mast is rigged with two 10-ton cargo booms with attachments and fittings for a 30-ton boom. The after mast is equipped with two cargo booms of 5 tons capacity. In addition, for auxiliary use, there is a coaling or cargo boom which is carried stowed on the deck of the ship and used for handling cargo at No. 3 port or for coaling the ship. The bunkers, arranged as shown on the plans, have a capacity of 478 tons. The ship has peak tanks forward and aft for fresh water; the capacities being respectively 45 tons and 94 tons.

The cargo holds and 'tween decks are ventilated by means of mechanical ventilation obtained by electric-driven fans and air ducts, by which is maintained at all times the thorough ventilation essential for carrying fruit and perishable cargo. There is also natural ventilation to all cargo spaces as well as to the public and private toilets, living quarters and elsewhere, including the coal bunkers, all of which is obtained by means of ventilating trunks, cowls and pipe trunk ventilators. The engine and boiler rooms are most thoroughly ventilated by large cowl ventilators, maintaining a low temperature for these spaces at all times.

General Arrangement

The hurricane, promenade and boat decks are given up almost wholly to the passenger accommodations and crew's quarters. The total first class berthing capacity is 295, contained in 118 first class staterooms, eight connecting suites with baths, and eighteen special rooms with toilets and thirty connecting rooms. Accommodations for ninety-eight steerage passengers are found aft on the hurricane and main decks. The steerage quarters are made up in rooms, together with toilets, mess room and all necessary conveniences. The sailors' quarters are forward in the forecastle head, where are also

FIG. 2.—DINING SALOON

quarters for the pantrymen, cooks, head waiter, boatswain, portman, watchman, butcher and bakers, steerage stewards, etc., together with toilets, wash rooms, etc. Below the forecastle head on the main deck are quarters for the waiters, together with toilets and wash room, mess stores and the paint and lamp room.

Forward in the bridge enclosure on the hurricane deck is the first class dining saloon, with a seating capacity of 180, aft of which, on the port side, is the first class pantry, and aft of that the officers' mess room, the dry storerooms, bake shop, scullery, first class galley, linen rooms, firemen's quarters, firemen's wash room and the cold-storage rooms.

On the starboard side of the hurricane deck, amidships, aft of the dining saloon is a spacious vestibule, with the second steward's room; still further aft are first class passenger staterooms and connecting rooms, and aft of the bridge enclosure, nearly amidships on the same deck, is the lower main social hall, and then additional first class passenger accommodations.

Amidships, in way of the engine and boiler casings, on both the hurricane and promenade decks, are the public toilets and bath rooms.

Leading up from the lower main social hall is the main grand stairway of the ship, which extends up into the sun parlor on the boat deck; aft of sun parlor are the bar, a spacious smoking room and toilet, and aft of the smoking room the deck veranda.

FIG. 3.—SMOKING ROOM

The promenade deck is given up entirely to first class passenger staterooms and public rooms. Forward is a spacious ladies' lounge, aft of which is a social hall, then a large stairway leads down to the vestibule aft of the first class dining saloon. Aft on the promenade deck, between the lower social hall and the sun parlor, are the music room and a social hall. Further aft are first class passenger staterooms and suites and also connecting special rooms with toilets.

Appointments

The interior finish, furnishings, decorations, etc., of the *Lenape* mark a new era in American coastwise ships. The

FIG. 4.—SPECIAL FIRST CLASS STATEROOM

vessel also has the special features known heretofore only in transatlantic ships, including a deck veranda, ladies' lounge and public spaces of this order. The first class dining saloon is an unusually large and spacious room for a ship of this size. The decorations and finish are taken from the Adam period of design. At the sides and ends of the dining saloon the finish is a deep, rich mahogany, with fluted pilasters extending to the ceiling, terminating in carved Ionic capitals. The space between the pilasters is old ivory white, the ceiling being finished in a cream white. At all the air ports ventilating sashes are fitted, glazed with special designs and painted glass from the Adam period of design, each window having an individual design. Over the center of the dining saloon is a large air well, such as is found on transatlantic ships. This well is enclosed in glass above at the ladies' lounge. At the top of the air well and above the ladies' lounge is a magnificent leaded glass dome.

FIG. 5.—DECORATION AT HEAD OF MAIN STAIRWAY

The ladies' lounge is finished in white mahogany with an unusual amount of carving. The lower main social hall and the music room above are finished in rich mahogany, fluted pilasters terminating at the ceiling in large carved Ionic capitals. The main or grand stairway is finished in rich mahogany with graceful curves, having iron grille balustrades. The sun parlor above is finished in enameled green, fluted pilasters terminating at the ceiling in Ionic capitals.

FIG. 6.—LOWER SOCIAL HALL

The smoking room is finished in high-grade quartered oak with softened colors. The floor of the smoking room is laid with a material known as "Compolite." Through the center of the smoking room is a glass well fitted with ornamental glass, to give ventilation and light to the social hall below.

The deck veranda is finished in teak, and is open aft for the exit of passengers to a spacious deck, over which is fitted an awning, in order that the passengers may go to and fro and enjoy the balmy air encountered on the route of this ship.

At the head of the grand stairway is a large oil painting, illustrating the Lenape tribe of Indians from which the ship's name was taken. This is a special feature heretofore unseen in any coastwise ships, the usual thing to be found at the head of a grand stairway being a plain mirror.

All the ordinary first class staterooms of this ship are finished in white enamel with mahogany trim. The suites are elegantly finished in white ivory enamel and rich mahogany. The baths and toilets of the connecting suites contain special plumbing fixtures with running hot and cold water. The floors are laid with hexagon tile and the wainscoting of these rooms with a glazed tiling. The special rooms of the ship are likewise finished in enameled white with mahogany trim.

FIG. 7.—LADIES' LOUNGE

The first class passenger staterooms on the starboard side of the hurricane deck in the bridge enclosure are fitted with large pivot air ports, which serve to give excellent ventilation when the ship is in motion. The inside staterooms have special ventilating trunks over them, to serve both for light and ventilation.

FIG. 8.—MAIN LOUNGE

Furnishings

The furniture in the public spaces of the *Lenape* is all portable, and equal to the best that can be found in the reception rooms of the best New York hotels. It consists of large and small-sized divans, large arm chairs and back-to-back sofas, upholstered in the richest fabrics in a variety of colors. The carpets and draperies in the Lenape's first class passenger staterooms, suites and public spaces, together with the floor

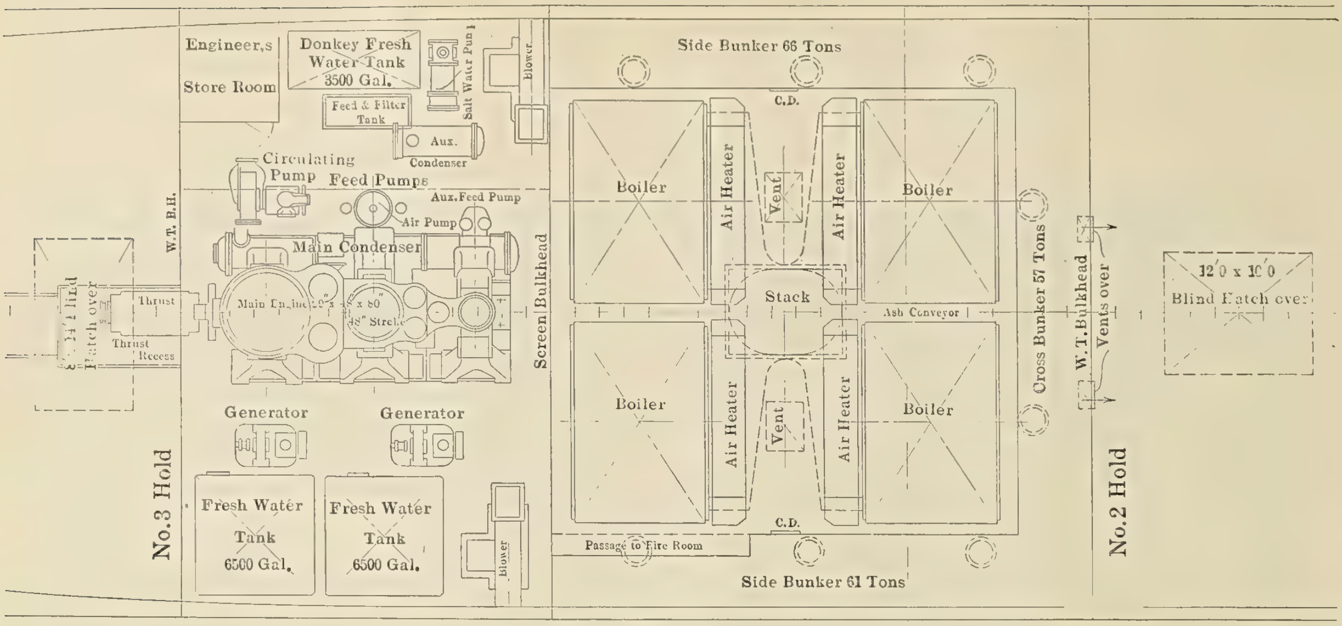


FIG. 9.—MACHINERY ARRANGEMENT

tiling, are of the best materials obtainable and of color and design to match, making the charming comforts of these public spaces all that could be desired on board ship. The ship is brilliantly lighted in every space. The electric light fixtures are of special design, neat and rich in character, hand chased and gold-plated, the fixture globes are of etched glass, all of which serves to perfect the illumination. A steam-operated vacuum cleaner is provided, by the automatic use of which everything can be kept thoroughly clean at all times.

EQUIPMENT

The life-saving equipment of the *Lenape* is modern in every particular. She has a full boat capacity for every person on board, including the passengers and crew. The fire apparatus consists of the most up-to-date appliances. There is, of course, a wireless equipment, for which two operators are maintained at all times, and a submarine bell is installed in the ship together with an electric fog whistle and all other modern appliances necessary for safe navigation.

BOILERS

Steam is supplied at 190 pounds pressure per square inch by

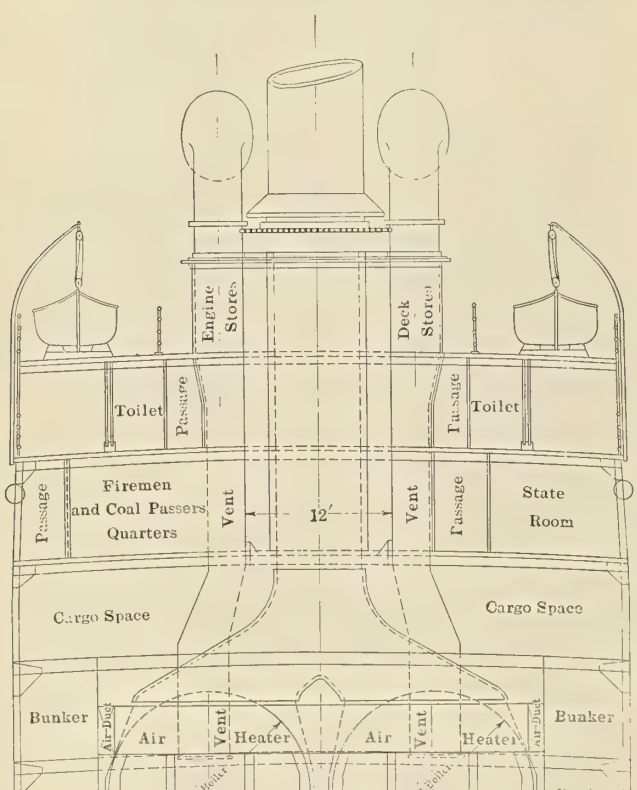


FIG. 10.—SECTION THROUGH BOILER ROOM

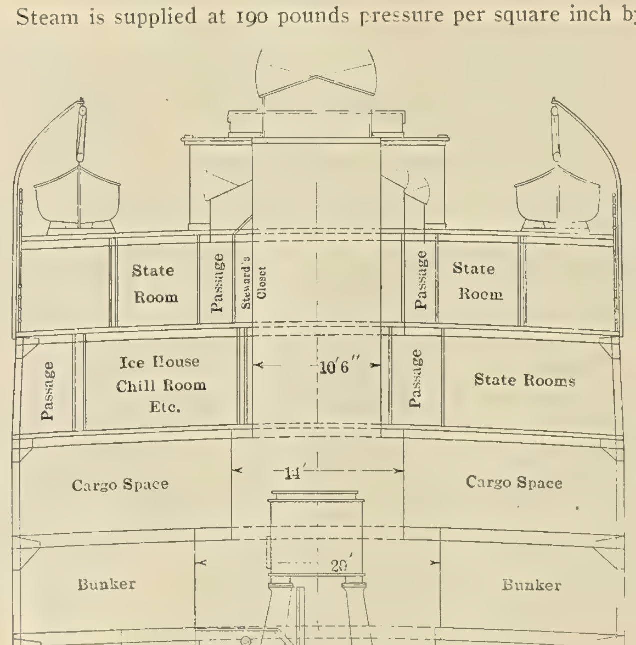


FIG. 11.—SECTION THROUGH ENGINE ROOM

four main boilers. Two of the boilers are 16 feet 6 inches in diameter, fitted with corrugated furnaces 42 inches in diameter, each boiler containing about 2,900 square feet of heating surface. The other two boilers are 14 feet 3 inches in diameter, each fitted with three corrugated furnaces 42 inches in diameter, and each containing 2,190 square feet of heating surface, giving a total heating surface for the four boilers of 10,180 square feet. The total grate surface of the four boilers is 265½ square feet. All of the boilers are fitted with Howden's system of heated forced draft, having the necessary heater tubes in the up-takes.

There is also a vertical donkey boiler located on the main deck above the fire-room. The donkey boiler is 5 feet inside diameter and 9 feet 6 inches high, containing 90 square feet of heating surface and 14½ square feet of grate surface. This boiler is of sufficient size to meet United States Steamboat Inspection Service requirements for a passenger ship.

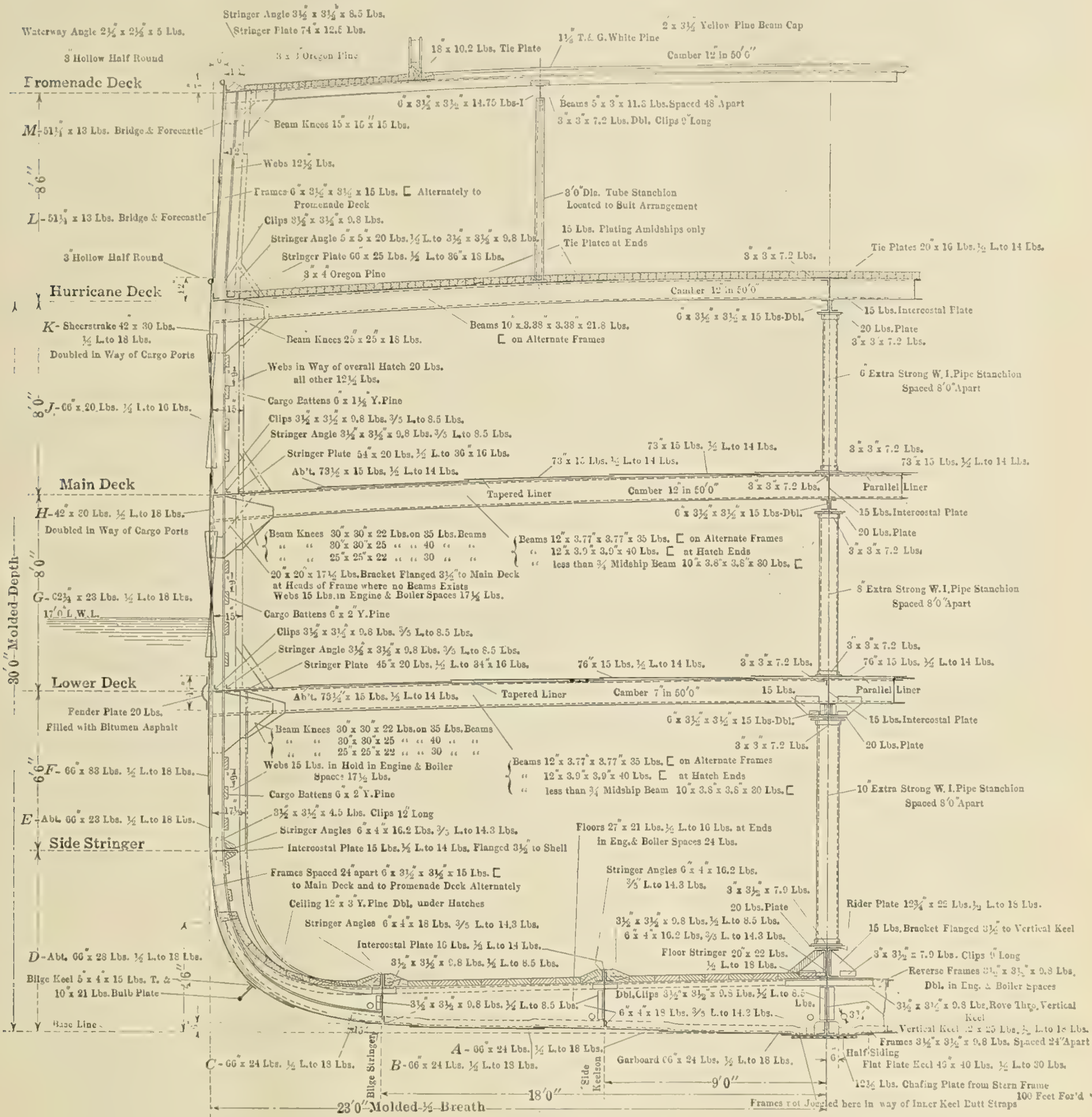


FIG. 12.—MIDSHIP SECTION

Propelling Machinery

The main engine is of the three-crank, direct-acting, reciprocating, triple-expansion type, with the high-pressure cylinder 28 inches in diameter, the intermediate cylinder 47 inches in diameter, and the low-pressure cylinder 80 inches in diameter, all with a common stroke of 48 inches. The engine was designed to operate at an estimated steam pressure of 190 pounds per square inch, and develops about 3,600 indicated horsepower at 90 revolutions per minute. The high-pressure and low-pressure cylinders each have one piston valve, and the low-pressure cylinder has two piston valves. All the valve gear is of the Stephenson type with double bar links. The main air pump, the lift pump for feed, two main feed pumps and one boiler pump are driven by double beams from the low-pressure crosshead.

The main condenser is built up with the engine back framing, and is fitted with tubes ¾ inch outside diameter. In addition to the main condenser, which contains about 6,000 square feet of cooling surface, there is an auxiliary condensing plant of about 750 square feet of cooling surface, fitted with ¾ inch outside diameter tubes. The auxiliary condenser is mounted on a horizontal combined air and circulating pump, 10 inches by 12 inches by 12 inches by 12 inches.

The main circulating pump is of the centrifugal type, with cast iron casing and brass impeller and shaft. The impeller is 42 inches diameter. The pump has 16 inches diameter suction and discharge connections and is driven by an 8 by 10-inch independent engine.

The main engine is fitted with a complete and convenient system for water-cooling the crosshead guides, crankpins, main bearings, thrust bearings and spring bearings, the water being supplied by the sanitary pump. In the engine room are fitted a revolution counter, clock, steam and vacuum gages, and engine telegraph of the reply type, Corey make, also voice pipes and mechanical telegraph for quick communication between the engine and boiler rooms, all suitably arranged. There are also fitted in the engine room the neccessary oil tanks and waste tanks, and at the after engine room bulkhead is an engineers' storeroom and workshop, while the various machinery spare parts are stowed about the engine room.

The main engine crankshaft, together with the thrust shafting, line shafting and propeller shaft, is of high-grade forged steel. The propeller is of the four-blade solid type, of manganese bronze, having a diameter of 15 feet and a pitch of 18 feet 3 inches.

Auxiliaries

Independent Pumps—Besides the independent pumps already mentioned in connection with the propelling machinery there is an auxiliary feed pump of the vertical duplex type, 12 inches by 8½ by 10 inches; one horizontal duplex water pump 6 inches by 4 inches by 6 inches, and one vertical duplex sanitary and water service pump, 12 inches by 12 inches by 10 inches, all of the Worthington make. There is also one main injector and one donkey injector.

Feed-Water Heater—A feed-water heater of the Blake vapor type is locted in the engine hatch. A feed and filter tank of rectangular shape, made of iron, is provided.

Piping—The main auxiliary steam pipes are of copper with brass flanges brazed on. There is one side main injection and one lower main injection. The steam lines for the auxiliary machinery are fitted with Leslie's reducing valves where necessary.

Generators—Current for electric lighting in the passenger quarters and cargo spaces is supplied by two General Electric direct-connected generators, one of 35-kilowatt and the other of 15-kilowatt capacity, located in the engine room.

Water Tanks—In the main engine room there are installed fresh water tanks for culinary use, having a total capacity of 12,700 gallons.

Refrigerating Machinery—The refrigerating apparatus consists of one Brunswick ice machine, having a capacity of 3 tons per hour.

Forced Draft Fans—There are two Sturtevant forced draft fans placed in the main engine room to supply heated forced draft for the main boilers.

Deck Pumps—Deck pumps are provided to meet the United States Steamboat Inspection Service requirements, one placed forward and one aft in the ship.

Steam Heating System—There is a complete steam heating system throughout all living quarters of the ship. It is of the return system, in circuits, and so arranged that the heat can be controlled independently in the passenger staterooms and public spaces, passageways and alcoves. Pipe leads of special pattern are fitted in the staterooms so as to be concealed from the passenger's view.

Cargo Hoist Winches—There is fitted at Nos. 1, 2, 3, 4 and 5 hatches, one double-cylinder, double-drum spur geared 8-inch by 8-inch cylinder steam hoister, and on the lower deck at hatch No. 4 a single-cylinder, spur geared, 8-inch by 8-inch steam hoister. All cargo winches are of the Williamson make. At Nos. 2, 3, 4 and 5 cargo hatches cargo swinging cranes are fitted, one on each side of the hatch.

Steam Steering Gear—The steam steering gear, made by the American Engine Company, consists of an 8-inch by 8-inch by 7-inch steam steering engine with drum, placed in the main engine room. There is also a hand-steering gear with leads to the steam steering gear. The steering engine is controlled from the pilot house by a hand-wheel and shafting to the steering engine.

Aft on the hurricane deck is an auxiliary hand-steering gear of the right and left-hand screw type, to be used in case of breakdown of the steam steering gear or the combined hand and steam gear from the pilot house.

Steam Windlass—The steam windlass, located in the forecastle head, is of ample size to handle the anchors and chain cables. It is of the pump brake type built by the Hyde Windlass Company, Bath, Me.

Steam Capstans—Actuated from the steam windlass placed on the forecastle head is a steam capstan 18 inches in diameter, also aft on the hurricane deck there is a steam capstan 18 inches in diameter operated by a vertical shaft from a capstan engine located in the cockpit below. Both capstans are of the Hyde make.

Performance of the Ship

The *Lenape* was designed for a service speed of 14 knots, her route being between New York, Charleston and Jacksonville and return. On her maiden voyage, which began on Jan. 22, 1913, the run from Scotland Lightship to Charleston Bar was made at an average speed of 15¼ knots, or 1¼ knots above her designed speed, which is a record for the Clyde Line. This was accomplished on a remarkably low coal consumption. On recent voyages the *Lenape* demonstrated excellent sea-going qualities in a moderate hurricane off Cape Hatteras, making excellent headway in heavy head weather, winning the admiration of her captain and officers and of the passengers.

William Froude National Tank.—The William Froude National Tank, established in connection with the National Physical Laboratory at Teddington through the munificence of Mr. A. F. Yarrow, is now in full working order and completely equipped to undertake the testing of ship models. This tank was intended primarily for research work in problems connected with ship propulsion, but it also undertakes model tests for private firms and individuals. The income of the tank depends partly upon fees charged for test work and partly upon the support of the leading shipbuilders and shipowning firms who have guaranteed an aggregate sum of $6,325 (£1,300) for several years to come. The annual expenditure on staff maintenance and operation of the tank is, however, estimated at about $12,180 (£2,500), and as it is desired to make a special feature of systematic research work, some of the results of which will be published in the transactions of the Institution of Naval Architects, it will not be possible to obtain from fees the balance of income required. Subscriptions are, therefore, sought from the shipowning and shipbuilding firms who are not already on the list of subscribers in order to bring the guaranteed sum for maintenance up to the required amount, so that the important work undertaken by the tank can be carried out without hindrance.

United States Naval Appropriations.—The bill for naval appropriations passed by the Sixty-second Congress provides for the construction of one first-class battleship carrying as heavy armor and as powerful armament as any vessel of its class, to have the highest practicable speed and greatest desirable radius of action and to be built in a Government navy yard; six torpedo boat destroyers, to have the highest practicable speed; four submarine torpedo boats; one transport and one supply ship.

Fast Turbine-Driven Yacht Winchester

Among the noteworthy additions to the fleet of the New York Yacht Club last year was the turbine-driven steam yacht *Winchester*, designed by Messrs. Cox & Stevens, of New York, for Mr. Peter Winchester Rouss, and built by Messrs. Yarrow & Company, of Scotstoun. The vessel is 205 feet in length, with a beam of 18 feet 6 inches, the hull being of steel and in design very similar to the recent torpedo boat destroyers, having a high raised forecastle associated with extreme flare of the forward sections, thus producing the best possible seagoing hull for a high-speed boat.

The vessel is flush-decked throughout, with a large dining room on the forward deck, the top of which is at the same level as the forecastle deck. There are two large funnels, one military mast and a large after-deck house, containing the companion stairs to the owner's quarters, which are located below aft. These quarters comprise a large, handsome saloon and the owner's room, extending the full width of the vessel, a large bath room with dressing room attached, and also two comfortable single staterooms and one large double stateroom with two baths.

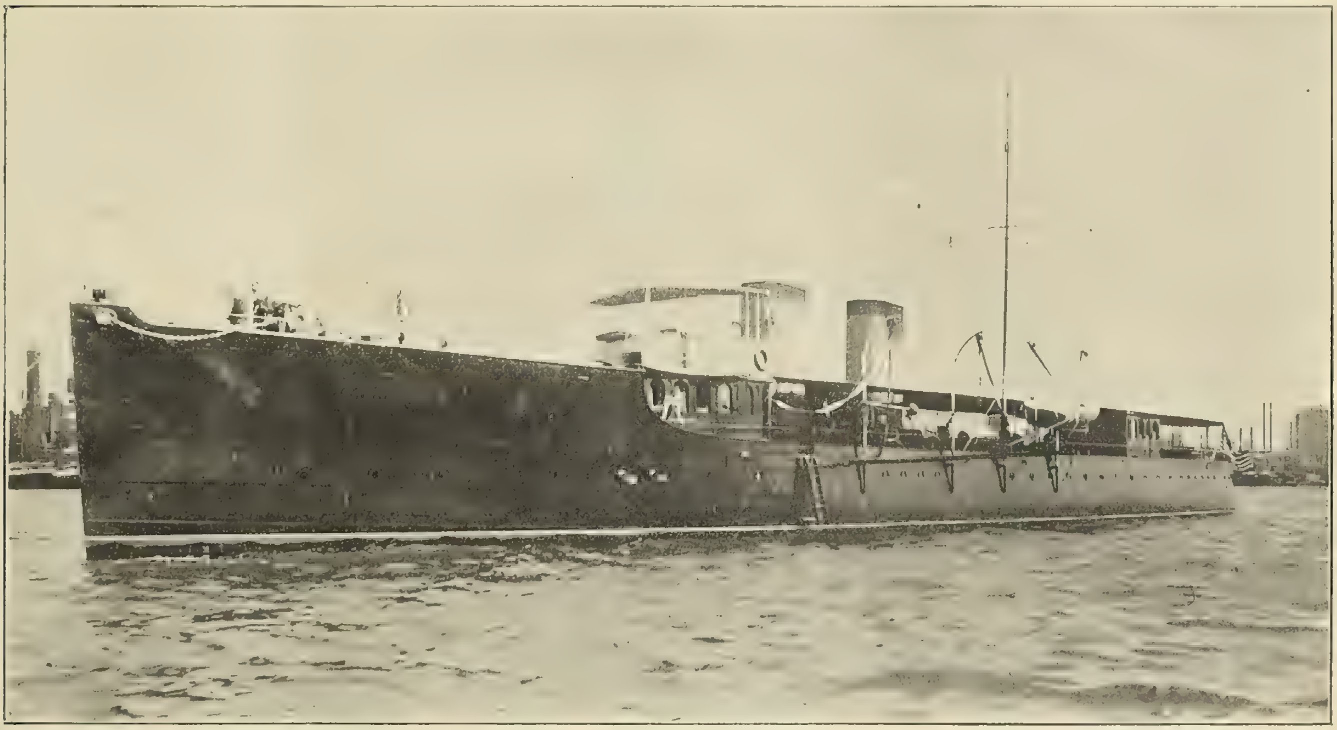


FIG. 1.—THE NEW WINCHESTER

The *Winchester's* machinery installation consists of Parsons turbines, driving twin screws, the total shaft-horsepower being approximately 6,000, steam being supplied by two oil-fired watertube boilers of the Yarrow type. The high-pressure turbine drives the port propeller and the low-pressure turbine the starboard propeller, an astern turbine being incorporated in the low-pressure casing.

Although the contract speed of 32 knots for which the *Winchester* was designed was considered unusually high, yet it is interesting to note that this speed is attained with a steam pressure of 165 pounds per square inch, whereas the boiler pressure allowed is 260 pounds, so that the vessel is capable of much more than her contract speed. In fact, a speed of 34 knots has already been obtained. On a preliminary trial over a measured mile with a steam pressure of 240 pounds at the boiler and 195 pounds at the high-pressure turbine, with a vacuum of 27¾ inches and an air pressure in the stokehold of 5 inches of water, a mean speed of 32.237 knots was obtained at 1188.6 mean revolutions per minute of the propellers.

While the figures for speed are remarkable, another feature that will be appreciated by yachtsmen is the fact that while running at high speed there is an absolute absence of vibration in the boat, and she moves through the water without creating any appreciable disturbance, so far as can be seen from the boat itself, the wake being perfectly flat and the diverging wave system being scarcely noticeable. Practically the only indication of high speed when on board, except for the swift passage of the water by the boat, is the thin and high bow wave which is turned down by the flaring sides, so that even in a cross wind with a choppy sea water and spray are prevented from coming on deck.

Besides the features already mentioned, the *Winchester* makes a very good showing as far as economy of operation is concerned. Her entire crew consists of only fourteen men, whereas the average engine room force alone in an ordinary steam yacht of her length, having a speed in the neighborhood of 21 or 22 knots, with about the same accommodation, using reciprocating engines and coal-fired boilers, is greater than the total crew of the *Winchester*. In addition to the saving in crew expenses, the consumption of fuel at cruising speeds proves very economical in spite of the fact that the vessel is heavily powered and designed for high speeds. During a recent trip from Halifax to New York she averaged better than 18 knots with no fire under one boiler and only one-half of the burners under the other boiler in operation, thus utilizing practically one-quarter of her total boiler power. Under these conditions her fuel consumption per mile is extraordinarily low, even as compared to the most economical reciprocating engine and coal-fired boiler installations, the total amount of fuel consumed for the voyage being 25 tons.

Oil fuel associated with turbine engines has for some time been the only combination considered by the navies of the

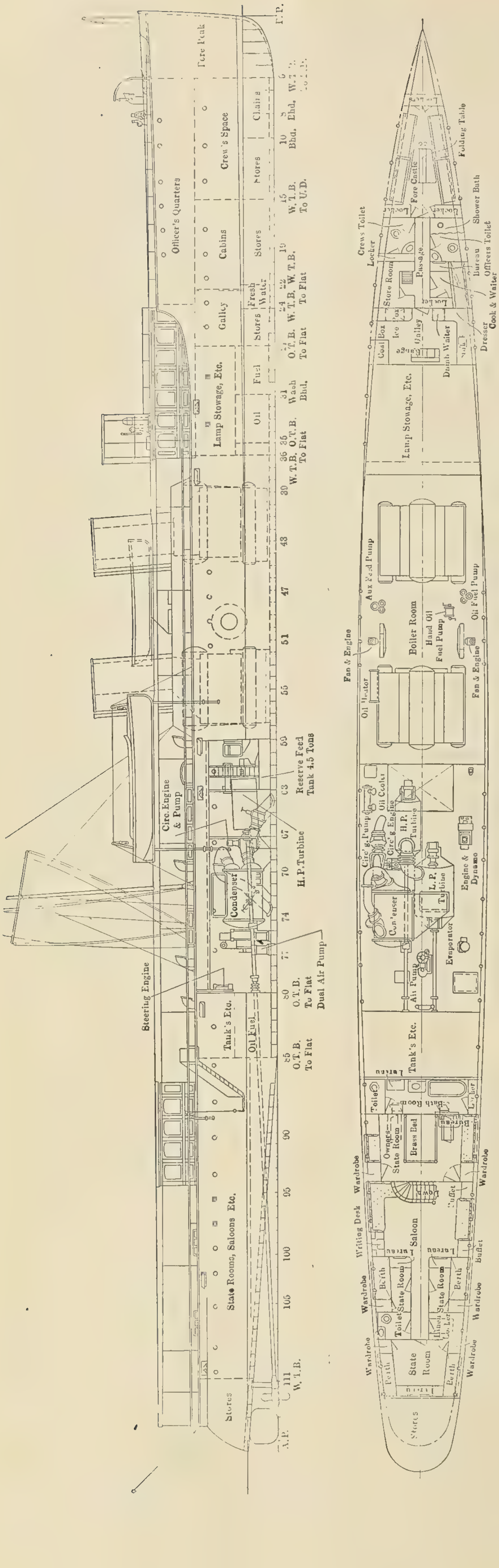


FIG. 2.—PROFILE AND DECK PLAN OF THE WINCHESTER

world for high-speed torpedo boats and destroyers, but until Mr. Rouss ordered the preceding *Winchester* from Messrs. Cox & Stevens this combination had not been successfully tried by yachtsmen. The complete success of the preceding *Winchester* (now the *Flying Fox*) led Mr. Rouss to commission the same architects to secure for him a larger and faster vessel having the same engineering features, resulting in the design and construction, with such excellent results, of the new *Winchester*.

A Motor-Driven Freight Ship

BY OUR BERLIN CORRESPONDENT

A freight ship driven by a crude oil motor has been recently built at Messrs. Fritz Bettin's Soehne's shipyards, at Tangermuende, Germany. The following are the main data of this vessel, which is remarkable in several respects:

Length over all..................	132 feet 8 inches.
Maximum breadth.................	15 feet 2 inches.
Minimum height at sides...........	8 feet.

The capacity of the *Bromberg*, as the vessel is called, is

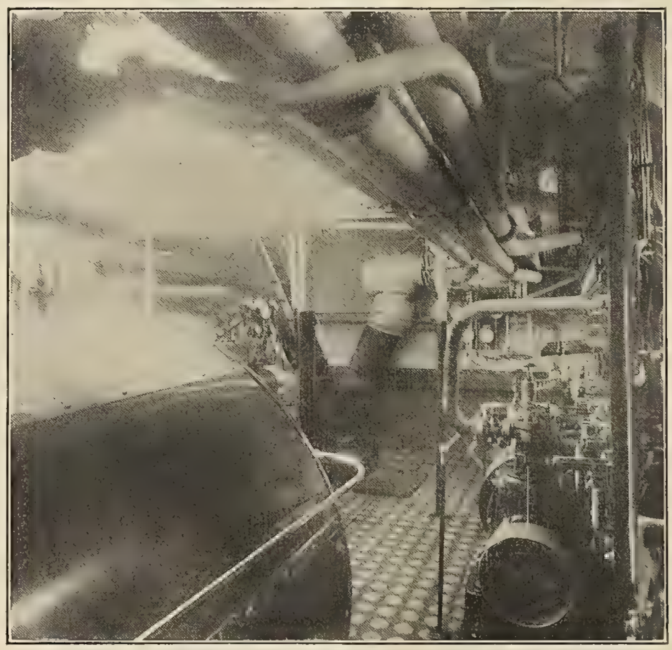


FIG. 3.—LOOKING FORWARD IN THE WINCHESTER'S ENGINE ROOM

197 tons, whereas that of a steamer of equal dimensions would be only 170 tons.

The 80 horsepower crude-oil motor, running at a speed of 325 revolutions per minute, has been designed by Messrs. Bolinders, of Stockholm. Its fuel consumption for each horsepower hour with full load is 250 grams of ordinary crude oil, as available at a low price in all ports of the world. It is a two-cycle reversible motor, imparting to the vessel with its full load a speed of 6 knots against the tide, with the average water level of the River Elbe.

The vessel contains the following compartments: In the rear, a compartment for all sorts of accessories, next to this a motor compartment with lateral fuel tanks followed by a rear hold, a captain's cabin in the center, and two holds, one of which is contiguous with the crew's cabin.

The bottom and sides are of shipbuilding steel, the former being riveted. There are two intercostal keelsons and hatches covered with corrugated sheet iron. The pilot's stand is behind the motor compartment, and there are two hoists and capstans.

Fig. 4.—Owner's stateroom on the Winchester

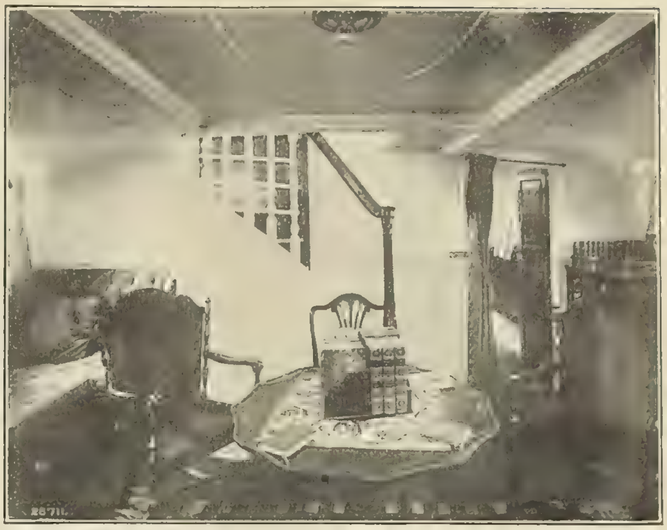


Fig. 6.—Main saloon on the Winchester

The following are the main advantages of motor-driven vessels of this type over freight steamers:

A reduction in the draft and increase in capacity and in the volume of the holds, absence of any stoker, permanent readiness for operation, absence of any dust as produced in coaling and in firing the boiler, absence of any boiler cleaning and overhauling, and finally the possibility of controlling the speed and reversing the motor by acting on a lever at the pilot's stand. Besides the reduction in crew's expenses and the increase in carrying capacity there is a saving in fuel consumption.

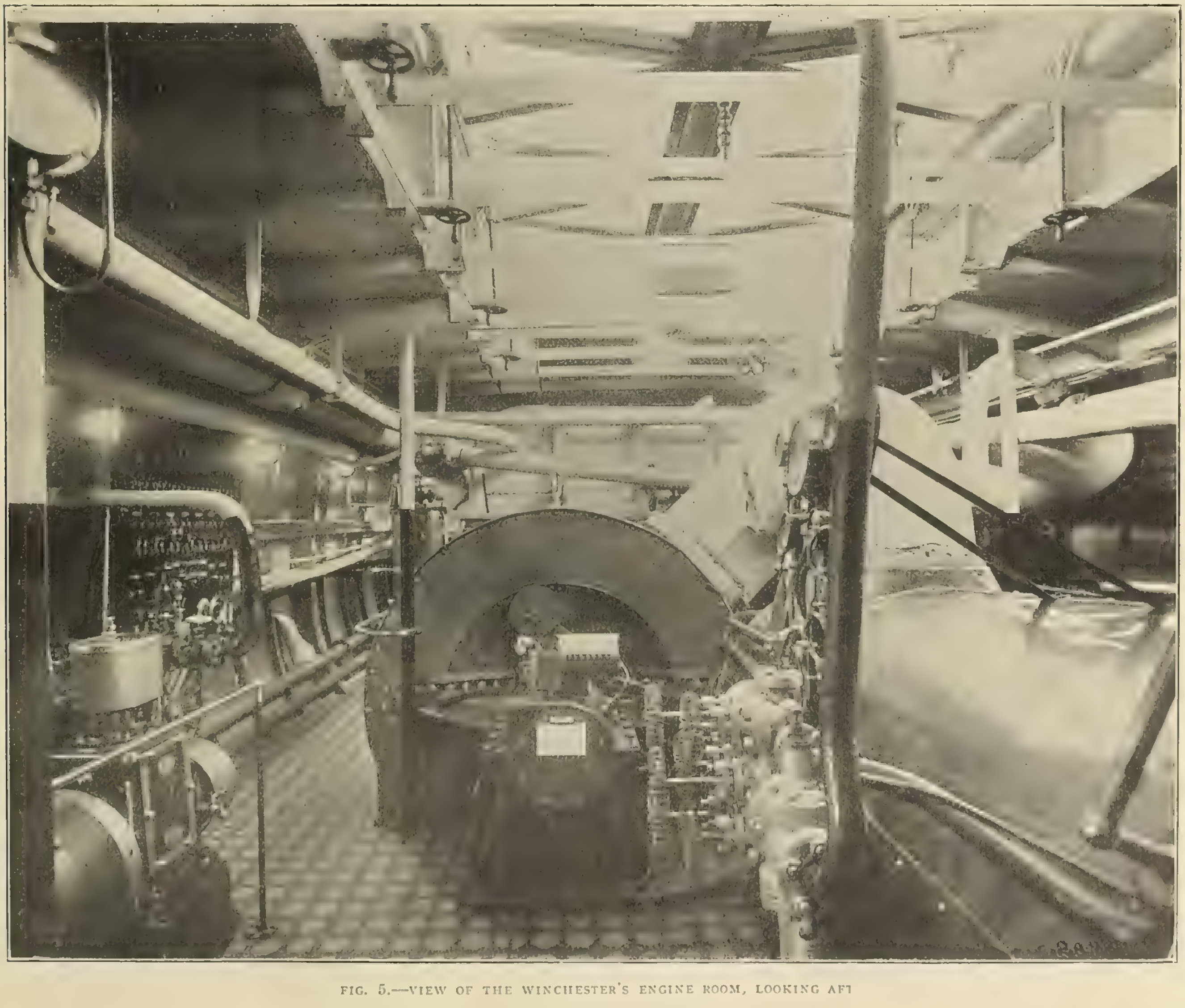


Fig. 5.—View of the Winchester's engine room, looking aft

Relaunching a Vessel on the River Clyde

BY GEORGE K. TURNBULL

The immense tonnage navigating the Clyde from Glasgow to the sea is by no means immune from accident, but seldom, if ever before in the history of the river, has a vessel been stranded in a field 20 feet from the river bank, as happened recently within 3 miles of Glasgow Bridge. The story of the stranding and subsequent relaunching of this vessel is of sufficient interest to record, especially as the salvage procedure would be somewhat similar in connection with any size of ship so situated.

The vessel referred to, the steamship *Carnalea,* was built by Messrs. Scott & Sons, Bowling, her dimensions being 178 feet 6 inches between perpendiculars by 28 feet beam by 13 feet molded depth. She was launched Nov. 26, 1912. A gale of wind, from about southwest, had been blowing throughout the previous night, and the morning of the 26th broke with little change in the weather conditions. The prospects of any launch taking place were not hopeful; in fact, some builders who had launches arranged for that day decided to postpone them till better conditions prevailed. A lull of the wind, however, induced Messrs. Scott to carry through their arrangements, and the launch was safely accomplished. The vessel was then taken in charge by two tugs and proceeded to Glasgow harbor, with the object of having the engines and boilers put on board and the fitting out completed.

Good progress was made up the river to a point midway between the shipyards of Messrs. Chas. Connell & Company and Messrs. Ritchie, Graham & Milne, where the tugs could not keep control of the vessel and she went ashore on the north bank. The tide by this time had risen to a most exceptional height, and the vessel, which drew 6 feet aft and 5 feet 6 inches forward, was carried over the bank and took the ground, the after end being 20 feet from the top of the river bank, and the forward end projecting over the bank about 5 feet, as shown in position 1, Fig. 1.

The ahead tug also went ashore and grounded on the sloping bank, which is here heavily ballasted with stone pitching. The precarious position of the stranded tug as she hung on the bank is shown in Fig. 2.

The work of taking off the tug was put in the hands of Messrs. Barclay, Curle & Company, under the supervision of Mr. Hugh Martin, of Glasgow, and Mr. Main, of Leith, for the insurance association concerned; the relaunching of the *Carnalea* was entrusted to Messrs. D. & W. Henderson & Company, Ltd., acting under the instructions of Capt. Robertson, on behalf of the London Salvage Association, and J. B. Cousins, Glasgow, underwriters' surveyor.

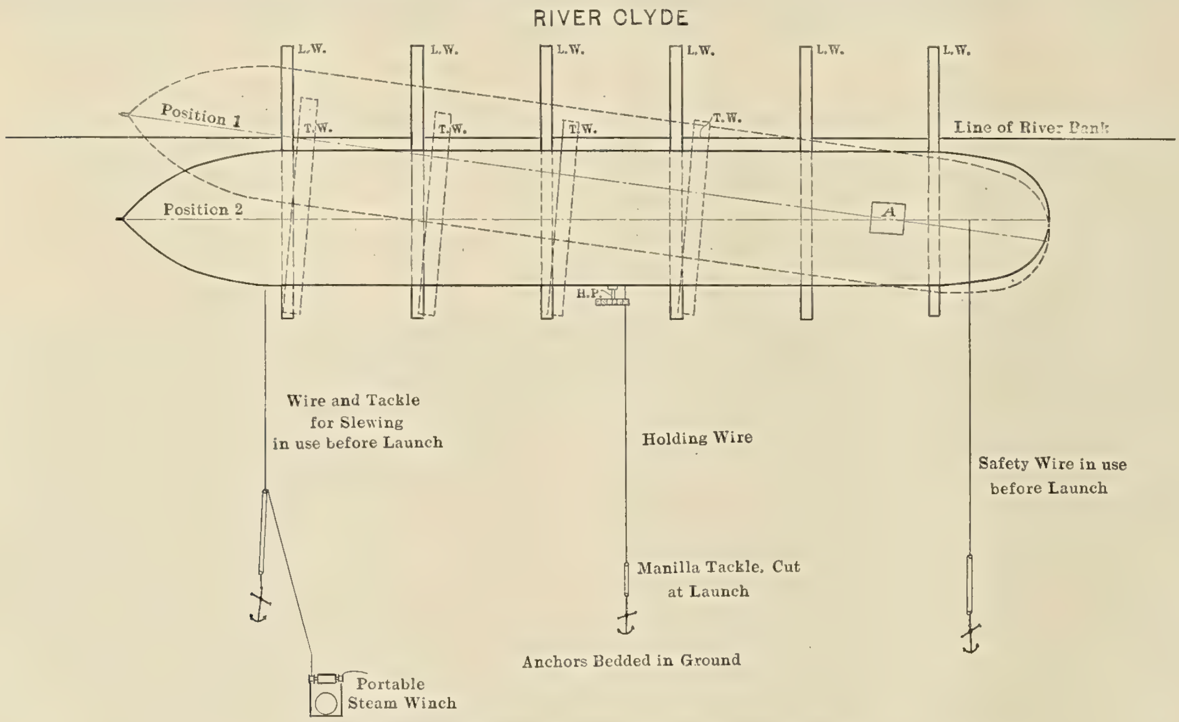


FIG. 1.—DIAGRAM SHOWING POSITION OF THE STRANDED VESSEL
T. W. are the temportry ways; L. W. are the launching ways, and H. P. is a hydraulic pump.

As a rule, when a vessel goes ashore even at high water it is possible to lighten her sufficiently to float her off at some subsequent high tide by discharging cargo, bunkers or ballast. In the case of the *Carnalea,* however, she was a newly launched ship and could not be appreciably lightened, and moreover she was situated about 2 feet above H. W. O. S. It was agreed from the first survey of the position that she would have to be relaunched.

Had it been possible to lay the launching ways far enough out into the river the vessel might have been launched directly from the diagonal position in which she lay, but as the formation of the river bank precluded this the first operation was to move the vessel around parallel to the river bank. This was accomplished by first digging troughs in the ground below the forward part of the vessel and laying in temporary ways and making her pivot upon a solid block, shown at *A*, Fig. 1, 20 feet from the stern post about which she slewed. The ground on the port side was removed from the point *A* forward as required. A wire tackle was attached to the fore part of the vessel and coupled to a treble wire purchase, the hauling part of which was led to a portable steam winch. When the weight of the vessel was taken on the timber logs she had a list of 2 degrees to starboard, but she was brought upright by wires and tackles before being blocked up for slewing into the required position. When this operation had been performed the vessel was parallel to the river at a distance of about 17 feet 6 inches from it, as shown in position 2, Fig. 1.

Six troughs were then cut and the final launching ways placed in position. Fig. 3 shows the transverse arrangement of the ways, and also shows the extent of the digging which required to be done on the river bank, over 10,000 cubic feet of earth and stonework being dealt with. The ways were set to a declivity of 1 in 12, and supported at the outer end as

FIG. 2.—TUGBOAT ON THE RIVER BANK

shown. The weight of the vessel was 420 tons, and the mean pressure on the ways about 1 ton per square foot. No dog shores were fitted, the vessel being held in place previously to launching by a wire passed right round the ship amidships and set up to a manila tackle, provision being made on board for speedily clearing the wire after launching. The vessel was released by the severing of the manila tackle, an hydraulic pump being fitted amidships to start the vessel if required.

The *Carnalea* was successfully relaunched Dec. 27 in the presence of a number of interested spectators and amid the hearty cheers of the workmen who had carried out this

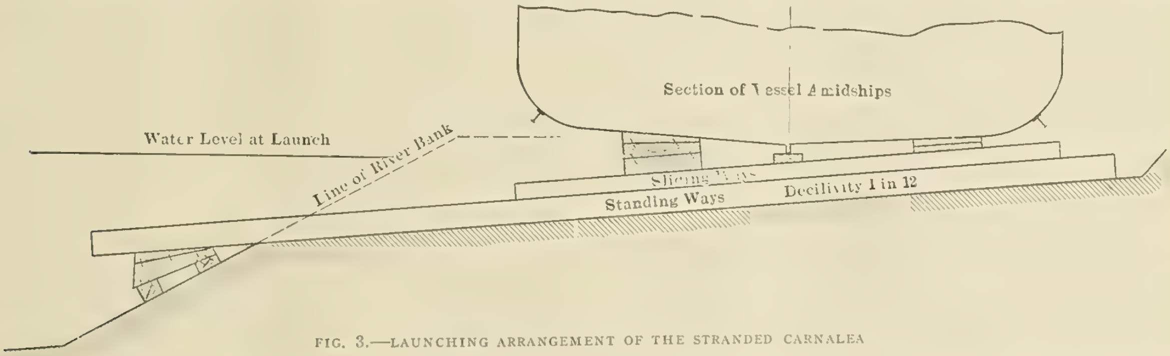


FIG. 3.—LAUNCHING ARRANGEMENT OF THE STRANDED CARNALEA

unusual piece of work. The time occupied in carrying out the complete operations from Dec. 3, when Messrs. Henderson received instructions to proceed with the work, was 21 working days. The weather during most of that time was extremely boisterous and wet, and much of the work which could only be done at low water had to be regulated to suit the tides. Considering these adverse circumstances, the time occupied and the thorough manner in which the whole operation was carried out and brought to a successful conclusion, reflect great credit on all concerned. The *Carnalea* was subsequently docked for examination, and it was found that she had sustained no damage from her unusual experience.

Westinghouse Leblanc Refrigerating System

Ammonia, carbon or sulphur dioxide, and dense air refrigerating machines are familiar to most marine engineers. There is, however, a certain range of temperature within which an even more familiar medium—water vapor—produces the desired cooling results, and, it is claimed, at a lower cost in power or higher efficiency. At the same time it is free from the difficulties attendant upon the other systems, such as the use of active chemicals and the maintenance of heavy reciprocating apparatus which are necessarily productive of difficulties in continued operation.

FIG. 4.—THE CARNALEA STRANDED BESIDE THE RIVER

The range of temperature referred to is between the approximate limits of 35 to 50 degrees F., and it is for the production of such temperatures, by the evaporation of water or brine solution, that the Westinghouse Leblanc refrigerating apparatus, manufactured by the Westinghouse Machine Company, Pittsburg, Pa., is peculiarly adapted.

The largest application for this system so far has been in connection with magazine cooling on vessels of the French navy, about thirty of which are so equipped at the present time. Fig. 1 shows the apparatus as installed on the French battleship *Danton*. This is a 10-ton machine, and is remarkable for its small dimensions, the length being 110 inches, width 63 inches, and height 71 inches. The complete weight is 5,500 pounds and the power required less than 10 kilowatts.

The principle of operation will be apparent from the diagram, Fig. 2. The water, or brine, to be cooled enters the top of the evaporator, and passes through the spraying plate, where the nozzles divide it into fine mist, in which condition it reaches the body of the evaporator vessel. This region, as will be seen later, is maintained at a very high vacuum, about 29.8 inches of mercury (one-tenth pound absolute pressure), which corresponds to a boiling temperature of about 34 degrees F. for either brine or water. The liquid, therefore, tends to vaporize, but since there is no heat supplied to effect this, the liquid gives up its own sensible heat until it is cooled to the temperature corresponding to the absolute pressure in the vessel. If, for instance, the brine enters the evaporator at 44 degrees F., each pound would fall 10 degrees in temperature, releasing 10 British thermal units, in cooling to the temperature of the vessel pressure, 34 degrees. Since the latent heat of

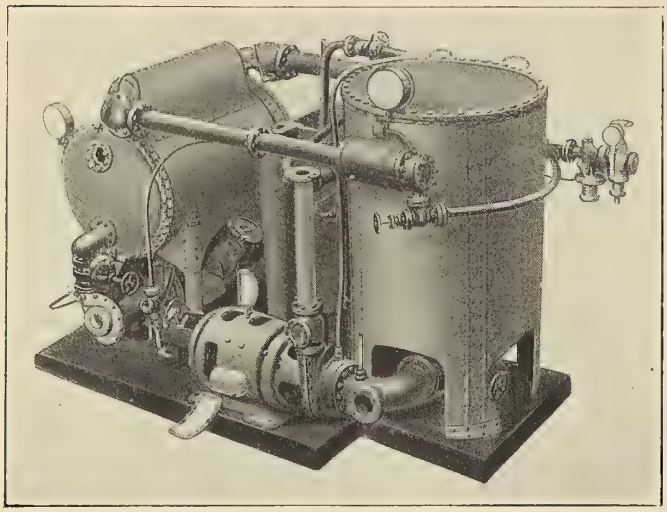


FIG. 1.—10-TON WESTINGHOUSE LEBLANC AIR COMPRESSOR

vaporization of 1 pound of brine or water at .2 inch of mercury is 1,090 British thermal units, the vaporization of 1 pound of brine will result in a 10-degree drop in temperature of $\frac{1,090}{10} = 109$ pounds. This large ratio accounts for the desirability of water vapor as a cooling medium, the heat-absorb-

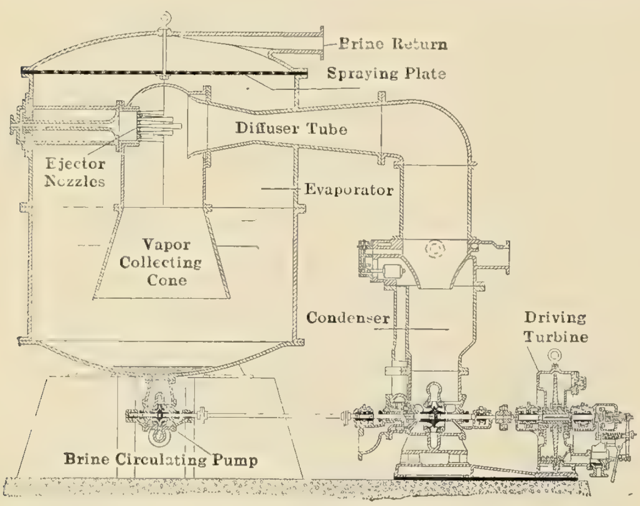


FIG. 2.—DIAGRAM SHOWING ARRANGEMENT OF AIR COMPRESSOR

ing capacity of a substance being a measure of the cooling effect obtainable.

The function of the vapor-collecting cone, ejector and condenser will now be apparent. In order to maintain the low pressure necessary in the evaporator the vapor coming off from the brine must be removed. A vacuum of 28.8 inches may be readily obtained by passing these vapors out through the collecting cone to a condenser supplied with 70-degree water. Since a vacuum 1 inch higher than this, or 29.8 inches, is desired, the steam ejector is employed, producing the additional inch by entraining the vapor and carrying it through the diffuser toward the condenser. The steam for the ejector may be supplied from the boiler plant, or any exhaust steam available may be used. In general, the amount required is about twice that formed by the vaporization of the brine. The condenser proportions must, of course, be such as to condense the total amount involved to a vacuum within about 1 inch of that required in the evaporator proper.

The structural simplicity of the system is apparent. The condenser, of the familiar Westinghouse Leblanc jet type, employs rotating pumps for the removal of the air as well as the circulating water and condensed steam. The extension of the shaft so that it will also drive the brine circulating pump makes a compact and relatively light outfit which has no wearing surfaces except those of the shaft journals. Although a non-condensing turbine is the generally advisable form of drive, a motor may be employed if desired. The system in which the brine circulates is closed with the exception that, due to the loss of water in the evaporator, a small amount must be added to maintain the proper dilution. This is preferably done just before the return to the spraying nozzles.

Institution of Naval Architects

At the annual meeting of the Institution of Naval Architects, held in the hall of the Royal Society of Arts, John street, Adelphi, on March 12, 13 and 14, the following papers were read and discussed:

March 12

1. Recent Developments in Battleship Type. By Alan H. Burgoyne, M. P.
2. The Influence of Air Pumps on the Military Efficiency of Turbine-Engined Warships. By D. B. Morison.

March 13

3. Mechanical Gearing for the Propulsion of Ships. By the Hon. Sir Charles A. Parsons, K. C. B., D. Sc., F. R. S.
4. Compressed Air for Working Auxiliaries in Ships Propelled by Internal-Combustion Engines. By W. Reavell.
5. The Energy Systems Accompanying the Motion of Bodies Through Air and Water. By Prof. J. B. Henderson, D. Sc.
6. The Calculation of Stability in Non-Intact Conditions. By Professor W. S. Abell.
7. Notes on Modern Airship Construction. By Baron A. Roenne.
8. The Longitudinal Stability of Skimmers and Hydroaeroplanes. By J. E. Steele, B. Sc.

March 14

9. On Large Deck Houses. By J. Foster King.
10. Methodical Experiments with Mercantile Ship Forms. By G. S. Baker.
11. Launching Declivities for Ships and Their Influence Upon Poppet and Way-End Pressures. By A. Hiley.
12. Stresses in Stayed Cylindrical Shells. By C. E. Stromeyer.
13. The Distribution of Stress Due to a Rivet in a Plate. By Prof. E. G. Coker, M. A., D. Sc., and W. A. Scoble, B. Sc., Wh. Sc.
14. Stresses in a Plate Due to the Presence of Cracks and Sharp Corners. By C. E. Inglis, M. A.

The annual dinner of the Institution was held on Wednesday, March 12, in the Grand Hall of the Connaught Rooms.

International Exhibition.—It has been proposed to hold an International Exhibition in Glasgow either in 1915 or 1916 to be devoted primarily to engineering and shipbuilding if a suitable site can be granted by the corporation. Sir A. McInnes Shaw, late Lord Provost, is chairman of the Provisional Committee, and the movement is supported by leading shipbuilders and engineers in the city.

Preservation of Metals for Marine Work*

BY LIEUT.-COM. FRANK LYON, U. S. N.

In taking the above title for this paper the writer intends to apply to vessels only under the two sub-divisions:

The metal of the hull.

The metals of the engines, boilers and machinery accessories.

The causes of the wasting away of such metals are three:

1. Corrosion.
2. Abrasion.
3. Erosion.

Corrosion is the most serious of the three, is ever present, and is the most difficult to combat.

Metals are weakened by all of the three causes and also by the continued variation of stresses in them. These variations tend to open up and emphasize the inherent defects in the metals due to segregation of the impurities in them and to their different physical characteristics which are induced or produced by the different temperatures at which they are worked during stages up to and including the finished article.

Corrosion, the chemical decomposition of metal, is due to the differences in electric potential between the metal and the liquid or moisture that wets its surface. It is produced only when the metal is wet or moistened by some liquid of lower potential than metal itself. Metals that are absolutely dry do not corrode, and wet metals corrode only on their wetted surfaces.

In this paper it is assumed that there is some definite, absolute zero of electrical potential similar to the absolute zero heat, and that all bodies and liquids have some definite potential at each temperature. When a metal at a certain potential is immersed in a liquid of lower potential the metal dissolves with the liquid and raises its potential; if the metal remains in solution in the liquid until the potential of the liquid solution is the same as that of metal, the solution is then saturated and no further dissolving takes place until the conditions of temperature or liquid solution are changed. If the potential of the liquid is the higher, the liquid exerts an electrical pressure on the metal but does not cause it to dissolve. If the metal can dissolve in the liquid, but is thrown out of solution as rust by some chemical agent inherent in either the metal or liquid, the dissolved parts do not raise the potential of the solution and the dissolving goes on to the extinction of the metal. The same results will be attained if the liquid is changed as fast as the metal dissolves into it, such as a plate on the side of a ship in a large body of water.

The diffusion of the dissolved parts of any substance in a liquid is believed to be due to the fact that the potential of the liquid is raised at the dissolving point, and that the tendency of all parts of any liquid body at different potentials is to equalize or come to a common potential. This in itself tends to keep the potential of the liquid at the dissolving point down until the potential of the whole body of the liquid is brought to the same as that of the dissolving substance. That is, the liquid becomes a homogeneous solution throughout its whole mass by diffusion of the dissolved parts into the solvent. If a metal has all of the points in its wetted surface at the same potential, and that potential is higher than that of the liquid by which wetted, it will corrode or dissolve at all of its points and general corrosion is said to exist. If the potentials of some of the points are higher and others lower than that of the liquid in which it is immersed, it will corrode only at the points where its potential is higher than that of the liquid, and local corrosion is said to exist with pitting of the metal as a result. The potentials of pure metals and liquids vary with their temperatures and with the way in which they are stressed, and those of impure metals and solutions vary in the same way, and also with the way in which the ingredients vary with the temperatures. That is, an alloy would not have the same potential that any one of its ingredients would have at the same temperature, but one common to that of all of the ingredients. Also, the potential of a solution at any temperature would not be the same as that of either the liquid or dissolved substance at that temperature, but at some one potential common to them both. In other words, the theory of potentials is assumed to be similar to the theory of heat. If two bodies—solid, liquid or gaseous—at different temperatures are brought near each other they assume a common temperature in proportion to the amounts of heat each contains, and it is easily conceivable that the same objects at different electrical potentials would come to some common potential in proportion to some inherent qualities of the two bodies in question.

If two metals are connected by a metal conductor and they are immersed in a liquid, and if one of them is at a potential higher than the liquid and the other at a lower one than the liquid, the higher one dissolves into the liquid and raises its potential, the liquid discharges its potential to the one lower than itself, and a current flows and the original condition is maintained. If the metal connection is broken, then the metal of higher potential raises that of the liquid, which in turn raises that of the metal of the lower potential, and eventually the potential of the whole becomes equal to that of the higher metal, no current flows, the original condition is destroyed, and the metal-water-metal series is polarized. A metal with different potentials at points in its surface immersed in water or a water solution acts in the same way. If all of the points are higher than that of the solution they all corrode until the potential of the liquid is raised to that of the lowest point on the metal. As the points of higher potential dissolve into the liquid and tend to raise its potential, the liquid then discharges its potential to the points in the surface lower than itself, a current flows from the high point to the liquid, from the liquid to the metal at the points lower than itself; the circuit is then complete, and local corrosion, as pitting, is the result.

This discussion on corrosion is made necessary by the subject matter that is to follow. The statements made above will be referred to in many places and would not be understood unless explained beforehand.

Abrasion is due to the wearing away of one substance by rubbing against another. In vessels' hulls it is mostly noticeable on the bows where rubbed and abraded by the anchors and chains. In their engines and machinery it is noticeable in the bearings, guides and similar construction, especially when not properly cared for. Its effect on the hull material is not serious and cannot be prevented in wake of the anchors and chains. There is no danger of damage from that source.

Erosion is due to the wash or scouring action of liquids or gases over metal at high velocities. With the exception of valves, and maybe in a few other places about the machinery, its effect will not cause sufficient loss to be noticeable.

Metals used in the construction of the hulls of vessels are: Steel for plates, angles, beams, rivets, struts and external and internal braces and hull fittings. Composition castings for sea chests and propellers. The compositions generally used are manganese and phosphor bronzes; monel metals (nickel bronzes) and an 88 copper, 10 tin, and 2 zinc bronze.

* A paper read before the Society of Naval Architects and Marine Engineers, New York, November, 1912.

Steels are extremely variable in the way in which they corrode and in their effect upon other steels to which they are connected by metallic contact. These variations are due to the differences in chemical compositions and to the differences in state of stress of the molecules of the metals in their wetted surfaces. These different stresses are in turn due to the different workings the metal has received, the temperatures at which it has been worked, and to the heat treatment finally given the finished product. Two pieces of steel from the same plate may vary perceptibly in the way in which they corrode and in the loss of weight per unit of area in a unit of time due to the above causes; that is, certain constituents may be segregated over the surface of one piece and not over the other, or different stresses may exist in the two surfaces, due to the different ways in which they have been worked or treated. An angle-bar corrodes more quickly than a plate of steel of practically the same constituents; a bent plate or angle-bar corrodes in and near the bend more quickly than the straight part. There is always more corrosion around the entrance, run and bilge of a vessel where all of the hull plates and frames are bent than along the straight body. A rivet that has been hammered and upset corrodes faster than the same rivet before it was hammered. The assumption that any piece of steel is a homogeneous body, either as to chemical contents or as to physical stress, is one that can very easily be disapproved by sufficient chemical analyses and by photomicrographic work. The writer was much surprised to note the differences in chemical composition and photomicrographic results in a boiler tube, samples taken (1) over the expanded surface and (2) over the unexpanded surfaces. He was also surprised to see the different ways in which boiler tubes corroded over the same areas, as shown both by Cushman and Walker's ferroxyl mount and by actual immersion. Steels are of higher potential than water at ordinary atmospheric temperatures.

Copper and copper compositions vary in the way they corrode. These variations are due to chemical compositions, variable temperatures, and to the way in which they have been worked, producing stresses in the surfaces of the finished product. At ordinary atmospheric temperatures copper and its compositions are of lower potential than water, *i. e.*, they are said to be electro-negative to water. As their temperatures are increased or as they are stressed to higher degrees their potentials increase faster than does the water in which they are immersed, and if the temperatures or stresses are raised sufficiently they become of higher potential than water and corrode or dissolve similarly to steel. As a proof of this, from observation on shipboard for thirteen years, copper and composition piping corrode faster at the bends and near flanges than at the straight parts, and pipes in which the temperatures are different in different places, such as feed piping through feed heaters, condenser and circulation piping, and other piping which is at different temperatures over different parts, corrode faster than do the fire mains and other piping which are at the same temperature throughout. Two pieces of copper or composition cut from the same plate, treated in the same way, may show no difference of potential when immersed together in water and connected through a potentiometer. Then if one piece is removed and hammered, worked or heated, and replaced, it will show that it is electro-positive to the unworked piece, and it will corrode if placed in water of a certain temperature in which the other piece may or may not be affected according to the treatment and chemical composition of the original sample. Composition castings are generally of a very uniformly stressed surface, due to the heat treatment naturally given in coaling. Those placed as sea chests in ships require no protective coating, and seldom, if ever, give any trouble, and the highest temperatures to which they are subjected are not sufficient to raise their potentials to equal that of the sea water in which immersed. If the copper compositions are segregated, and these segregated spots are of higher potential than sea water, they dissolve away and pit to the depth to which the segregations extend.

These compositions are negative or lower in electrical potential than ordinary or sea waters, while steels are electro-positive or of higher potential than the same waters at ordinary temperatures. If the bare steel is immersed in the water it will corrode or dissolve at all points in its wetted surface, while the composition casting in the same waters will not corrode at any of its points. If these two metals are connected by a perfect metallic contact and immersed in the same water, the rate of corrosion over the steel will be greatly increased. The rate at which it will be increased all over its surface will depend upon the perfection of the metallic contact; if there is no such contact the presence of the composition will not increase the rate of corrosion on the steel, no matter how close together they may be. If the steel is covered with a moisture-proof paint and the same contact as above made, it will not corrode when connected by a perfect metallic contact with the compositions, but if the film of the moisture-proof paint is broken so that any part of the steel surface is exposed to the water it will corrode rapidly over the exposed part.

Where these composition castings are secured to the steel hull of a vessel it is customary to secure plates or rings of rolled zinc as a protection to the steel, the idea being that the zinc, being of higher potential than the steel, will corrode and preserve the steel. That this assumption is thought to be correct is evidenced by the great use of zincs at a very large cost in these places. Yet the writer has failed to see that the assumption is positively correct for the following reasons: (1) Zinc quickly corrodes and becomes covered with zinc oxide, and zinc oxide from boiler, condenser and hull zincs has been found to be electro-negative to steel in every case tried. (2) In no case has the writer ever had a piece of steel connected to a zinc plate corrode less in the same water in thirty days than a piece of steel from the same plate placed alongside the first plate, but not connected to zinc. (3) The steel around the sea chests of the bottom blow discharges, if properly painted, does not show more corrosion than does that around the other discharges, and the writer has never seen a ship docked that had any zinc in the bottom blow discharges, they evidently having deteriorated and been blown out soon after the previous undocking. (4) It has been noticed on many occasions that the only steel attacked by corrosion in the vicinity of the zinc plates was that of the steel screws holding the zincs in place. Therefore the writer fails to see the necessity of the zinc protectors, especially as he has just seen the bottom of a ship on which, after having been in the water over six months, there were no signs of corrosion at any point when the paint film was unbroken except on the zinc.

The use of zincs and other metals electro-positive to steel in galvanizing, electro-plating, or other similar covering processes, as a preservative for it, when continuously immersed in water, is a dangerous one, and is not to be commended for the following reasons: (1) The metal covering must be electro-positive to the steel or metal to be protected, therefore it is more soluble in water and will dissolve more quickly. (2) When the steel is once exposed to the action of the water it corrodes rapidly over the exposed surface, and if not stopped by some similar covering it will pit through before other surfaces are uncovered. (3) For hull and ship fittings generally a surface once exposed cannot be again covered. (4) The stable oxides of all metals are lower in the potential series than the pure metals, therefore the oxide of the coating may be lower in potential than the metal to be protected, and actually does harm instead of good where the steel is exposed.

For the protection of the hull construction it therefore remains only (1) to provide the most homogeneous metals possible both in regard to chemical composition and physical structure. (2) Paint the completed structure with a complete film of the best anti-corrosive paint that can be obtained, after having cleaned the surfaces of all foreign matter and rust and dried them thoroughly. After this film of paint is dried give the surfaces a second coat of the same paint; after this coat is dry paint with an anti-fouling paint for all outboard, under-water structures and with the best moisture-excluding paint for all other surfaces. (3) Dock frequently and remove any rust that may be found, and repaint as may be necessary. (4) On inboard structures remove all paint that shows active corrosion under it, and when thoroughly cleaned and dry repaint as before.

The subject of proper painting is a very important one and one that must be thoroughly understood to obtain good results. There are three necessary points that must be observed and understood as follows: How to paint, when to paint, and what kind of paint to use for the different conditions the paint has to stand.

How to paint involves the question of the proper preparation of the surfaces, the proper preparation of the paint, and a proper spreading rate of the kind of paint used.

When to paint involves the question of the dryness of the surfaces and the atmospheric conditions in the vicinity of the surfaces. What kind of paint to use involves the questions of whether the paint is to be used (1) as a protection to the metal (anti-corrosive and waterproof paint), (2) as a cleanser of the paint film of marine growth (anti-fouling or poisoned paints), (3) as a decoration to the structure (covering and coloring paint). In any of the above cases the paint film when dry should have about the same coefficient of expansion as the metal to be covered, or the painting will crack or become loosened from the surfaces, and any good effect, even unto decoration, will be lost. An anti-corrosive paint is one that, when well dried, is impervious to moisture, and keeps the metallic surface dry, so that no active corrosion can take place, and one that, when moisture does percolate through it to the metal, dissolves and raises the potential of the enclosed water to a point as high or higher than that of any metal exposed to it. To perform this last function the pigments of the paint must be higher in the electromotive series than the metal to be covered, and to perform the first the pigments and solvent must form a homogeneous film over the whole of the covered metal. An anti-fouling paint is one that, when any marine growth sticks on its surface, either poisons the growth and allows it to drop off or dissolves under the growth, due to its secretions, and allows it to loosen and float away. Decoration or distinguishing paints are those used to decorate the living quarters or to distinguish different kinds of piping. About the only requirement for them is that they must have a pleasing or distinctive color, and the color must last as long as possible under the conditions of the service to which they are exposed. Many good anti-corrosive paints are not good waterproof ones; therefore, unless the anti-corrosive paint is a good waterproof one, it should be covered with a good waterproof paint, for the protective effect of a non-corrosive paint is obtained at the expense of the paint unless it is also a good waterproof one. As soon as enough of the paint is dissolved off to enable a free circulation of water to the surface of the metal the anti-corrosive effect is lost. Proper painting is a most important aid in the preservation of metals, and no effort should be spared to obtain it. The first cost of painting for the protective effect must be disregarded, and the best paint obtainable for the purpose used and applied with the greatest care. There is a general tendency in some directions to regard painting as only for decorative purposes and to consider that the cheap paints frequently applied are the best. Even for decorative purposes this is not true, because a proper paint properly applied will generally last at least three times as long as an improper one at half the price. Judging from the amount of surface to be covered, the conditions of its service, the number of men to do the work, and the other work they have to do, the best paint, properly applied, is none too good and should be obtained at any cost. The writer once put a coat of white enamel paint on the above-water sides of a gunboat in service on the Yangstze-Kiang River which lasted without retouching for over one year. It looked well all the while although washed daily with muddy river water.

As active corrosion cannot take place on dry metals it may often be better not to remove a good film of paint that has been put on over dry dust, and through which no signs of active corrosion are visible, than to spoil the paint for the purpose of removing dry and therefore harmless rust unless it is perfectly sure that a properly dried paint film can again be obtained over perfectly dry metal. The writer has on several occasions done more harm than good by removing good, dry paint films previously put on over dry rust because he could not get the surfaces dry and a proper film of good paint to stick to them.

The metals used in machinery, boilers and their accessories and piping are many, such as

Cast iron for cylinders and engine housings.

Steel for steam pipes, boilers, shafting, tanks, evaporators, condensers, feed pipes and general piping.

Composition for water boilers, of pumps, water pipes, valve fittings, boiler fittings, condenser tubes and in other places.

Copper for small piping and in other places.

Monel metal for valve fittings, pump liners, pump rods and such other places.

Cast steel for superheated steam valves, slip-joint castings, etc.

Lead as a lining for iron or steel pipes.

Other metals are used but the above are the principal ones. The same observations apply to these metals that can be painted as previously stated for hull materials.

Oil films are moisture-proof when applied to dry metals, therefore there is very little if any corrosion taking place about an engine when it is in use. Paint around the usual main engines and their framing is unnecessary unless the engine is to be laid up for a long period, and, if used, is for the purpose of decoration only. The external sides of pipes, feed heaters, condensers, boilers, evaporators and tanks can be protected by proper paints. The internal or water side of the above cannot be protected by paints, nor is it generally believed by any other means; though lacquers, galvanizing, lead lining and other means have been tried on pipes, they have all proved unsatisfactory, in some cases due to the unequal coefficients of expansion of the coating and metal, in some to the solubility of the lacquer, and in others to the fact that the metallic coating cannot be properly applied to the finished article. As the life of piping, boiler plates and other parts is no greater than the weaker part, the piece fails when improperly protected. Boiler, condenser, feed-water, distiller and evaporator tubes cannot be protected on either side by paints, lacquers and coatings. Therefore all such parts should be made of homogeneous metals properly heat-treated after being finished, and then fitted properly so that the least possible internal strains are brought into it due to the fitting.

It has been definitely proved that any water made alkaline enough to show 3 percent of normal alkalinity with calcined sodium carbonate is non-corrosive to steel at all temperatures up to 422 degrees F. Therefore if the water in the boilers, tanks, evaporators and feed piping is kept at or above that strength with sodium carbonate at all times, no corrosion will take place, while if the strength is allowed to fall to about

1.8 to 2.5 percent, bad pitting will take place. In trying to reproduce the pitting continually taking place in boilers, tanks, piping and on bilge plates with acid solution, or plain sea or distilled water, the writer failed in every instance on three grades of nearly pure irons, three grades of boiler steel, and on four grades of cast iron. It was easy to produce such similar pittings on all of them when immersed in weak alkaline and very weak carbonate solutions. For the above reasons it is believed by the writer that much more harm is done in enclosed metal vessels by water made slightly alkaline, either artificially or naturally, than is ever done by the small percentage of acids that ever enters the average boiler. Boilers and other water-containing metal vessels or conduits containing acid water will go to pieces quickly, practically all over at the same time; those containing sea or distilled water will go to pieces all over at the same time but very slowly; those containing alkaline water of a strength not high enough to stop all corrosion will go to pieces in the weaker places, while other parts or places will remain perfectly good. If the percentage of alkalinity is high enough no corrosion whatever will take place. The reason for this is believed to be as follows:

1. Water has a certain definite potential at any definite temperature.

2. Pure distilled water has a potential lower than that of steels, irons and some alloys.

3. Acids added to pure distilled water at any temperature decrease its potential.

4. Alkaline substance dissolved in pure distilled water increases its potential.

5. The decrease of the potential of water when an acid is dissolved in it is due to the fact that the negative ion of the acid is lower in potential than that of the hydroxyl OH of water, the H ion being common.

The increase in potential of water when an alkaline substance is added to it is due to the fact that the metallic or positive ion of the alkali is higher in the potential series than hydrogen, while the hydroxyl or negative ion is common to both.

6. When any metal is wet by any water solution, if the potential of the solution is (*a*) higher than that of the metal at every point on its surface, the metal will not corrode; (*b*) higher than some points in the metal surface and lower than that in others, the metal will corrode only over the areas where the potential of the solution is the lower; and it will corrode faster over those points than it would if immersed in distilled water alone, due to the fact that though the difference of potential between that of the metal and that of the alkaline solution is less than it would have been in distilled water, yet the conductivity of the water has been greatly increased by the addition of the alkaline substance; (*c*) lower than that of the metal at any point it will corrode all over at the same time, faster over the higher potential points than over the lower ones. The rate of corrosion over all of the points will depend both upon the difference of potential between the metal at the point and the solution, and also upon the conductivity of the solution. As the alkalinity of the solution decreases, the difference of potential between the metal and the water increases and the conductivity of the solution decreases until pure water is reached. Any addition of an acid then increases the difference of potential between the metal and the solution and also increases the conductivity of the solution. When considered with a given metal the potential of some alkaline solutions increase faster with a rise in temperature than does that of the metal, therefore a solution that may not be dangerous at ordinary atmospheric temperature may be strongly active to the same metal at higher temperatures.

Also a solution that may be strongly active to metals at atmospheric temperatures may be non-corrosive entirely at still higher ones.

The converse may be true with some of the alkaline substances; that is, a rise in temperature may not increase the potential of the solution as fast as it does the metal and a safe solution at atmospheric temperatures may be unsafe at higher ones. In the writer's experiments with alkaline solutions the general rule was that a one one-hundred-thousandth and a one ten-thousandth normal concentration of alkaline solutions decreased the rate of corrosion of irons and steels slightly below that in distilled water and caused no pitting, while the one one-thousandth and one-hundredth concentrations increased the rate above that, and caused very active local corrosion or pitting until the 2.6 percent normal concentration was reached, when all corrosion stopped.

Cement washing the plates of drinking water tanks has its advantages, but the washing must be done with great care, will not stick to paint and is not durable. It must be watched centration was reached, when all corrosion stopped.

The Cumberland Electrical Process appears to be the only way of preserving the interior surfaces of water-carrying pipes and circulating systems. It is on the same principle as the alkaline theory. The potential of the water is raised to a point higher than any point of the system by sending a current from an outside source to it from an easily replaced anode. The current must be at a potential high enough to raise that of the water to the proper point and must be kept on continuously. If the potential of the water drops below that of the metal at any point it will pit or corrode at that point similar to the alkaline solutions. This system will give excellent results when properly installed and properly attended.

The preservation of copper, composition or iron piping on board ships in the flushing, condenser and refrigerator circulating systems can be maintained by the Cumberland process if run by some electrical source other than the main power system of the vessel. This process has many drawbacks and requires constant attention. Except by making the piping and tubing of the best and most homogeneous metal obtainable, having it properly made and the finished article properly heat-treated and fitted, it seems to be the only practicable plan available. It is sure if properly controlled.

The wrought iron, steel and other iron manufacturers make many claims for their various materials, claiming maximum durability and resistance to rust. In thirty months of continuous testing of these various products it was interesting to note that in many cases one would show much better than another, but by varying solution, temperature and treatment they could all be made to give practically similar results.

In waters that are made non-corrosive to iron or steel by alkaline solutions, their metallic contact with copper and other metals lower than iron in the potential series does not start corrosion.

These notes and observations are made after thirteen years of active sea service as both an engineer and line officer in the United States navy, and after nearly three years' work on corrosion problems at the United States Naval Academy. The writer offers them for whatever of interest they may be to anyone.

Monthly Shipbuilding Returns.—The Bureau of Navigation reports 109 sailing, steam and unrigged vessels of 38,201 gross tons built in the United States and officially numbered during the month of February. Of the total number of vessels built 8 were steel steamships aggregating 29,294 gross tons. Five of these, aggregating 17,879 gross tons, were built on the Atlantic and the Gulf coasts, while two, aggregating 10,088 gross tons, were built on the Great Lakes. The largest of the vessels completed was the naval collier *Jason* of 10,650 gross tons, built by the Maryland Steel Company, Sparrows Point, Md.

Motor Lightship Bürgermeister O'Swald

BY J. RENDELL WILSON

Shortly after the *Titanic* disaster it was suggested that a number of Diesel-engined lightships should be built by the Great Powers and stationed in those parts of the Atlantic most subject to icebergs. Such craft would be equipped with wireless telegraph installations, and would be able to warn the great liners and other ships. The advantage of motor power for such ships would be that they would have four times the cruising range of steamboats of similar displacement —in fact, one "oiling" would probably be sufficient to last the whole of the period in which icebergs are generally to be found in the steamship track, especially as unusually large fuel tanks can be installed where an ordinary craft would carry cargo or passengers.

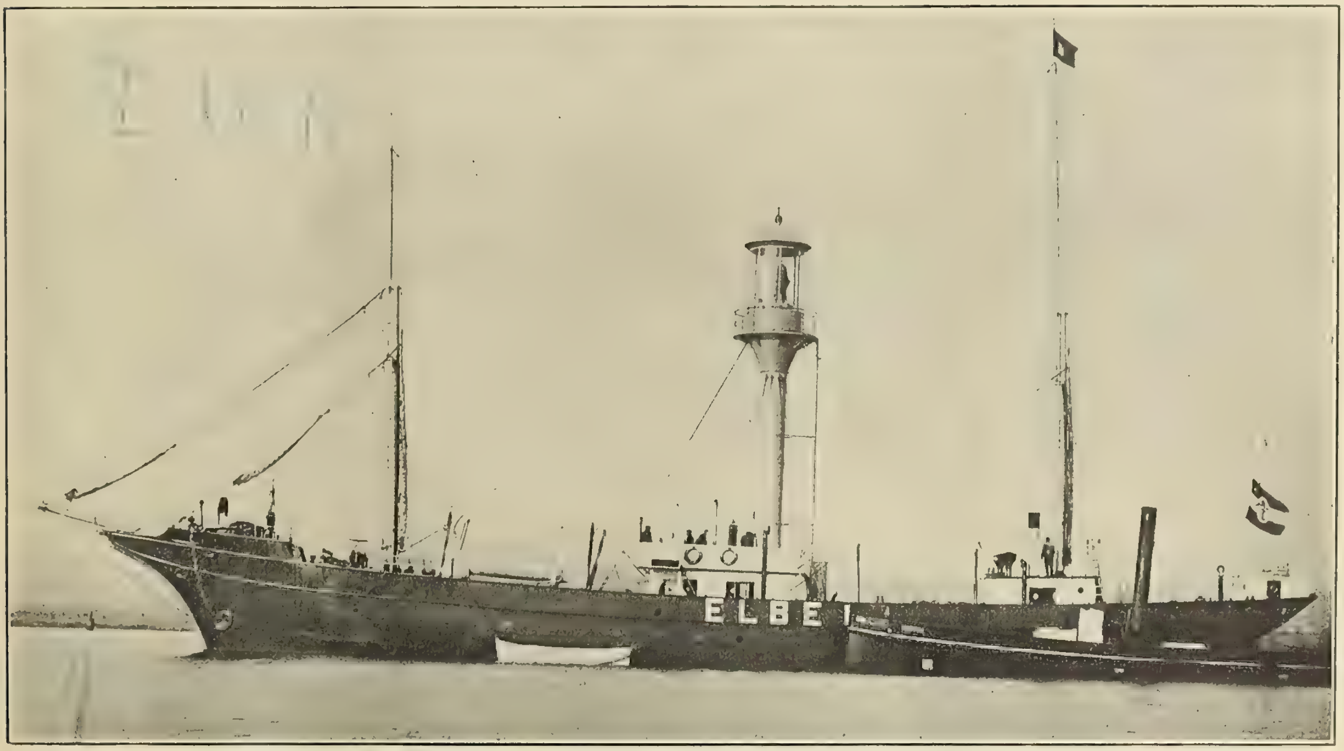
An interesting vessel of this class has just been built and stationed in the North Sea at the mouth of the river Elbe by the Handel, Schiffahrt, and Gewerbe des Hamburger Staates. She is just under 173 feet in length overall, 137½ feet on waterline, by 25 feet 3 inches beam, with 17 feet 4 inches molded depth, and has a draft of 13 feet 1 inch on a displacement of 720 tons. She was built from designs by M. H. E. Johns, of Hamburg, at the Stettin yard of Messrs. Nüscke & Co., to the German-Lloyd Class 100 A-4, and is rather a smart-looking craft with clipper stem and a good sheer line. A complete wireless installation has been fitted. She has been named *Bürgermeister O'Swald.*

The special interest in this vessel lies, of course, in the machinery, both the propelling and auxiliary engines being of the Diesel type, consuming heavy residual oil as fuel, so it will be seen that ordinary running costs will be low, also the machinery—lighting or propulsive—can be stopped or started at a few minutes' notice; whereas the expenses of a steam lightship would be very high, as it would always be necessary to maintain a good head of steam.

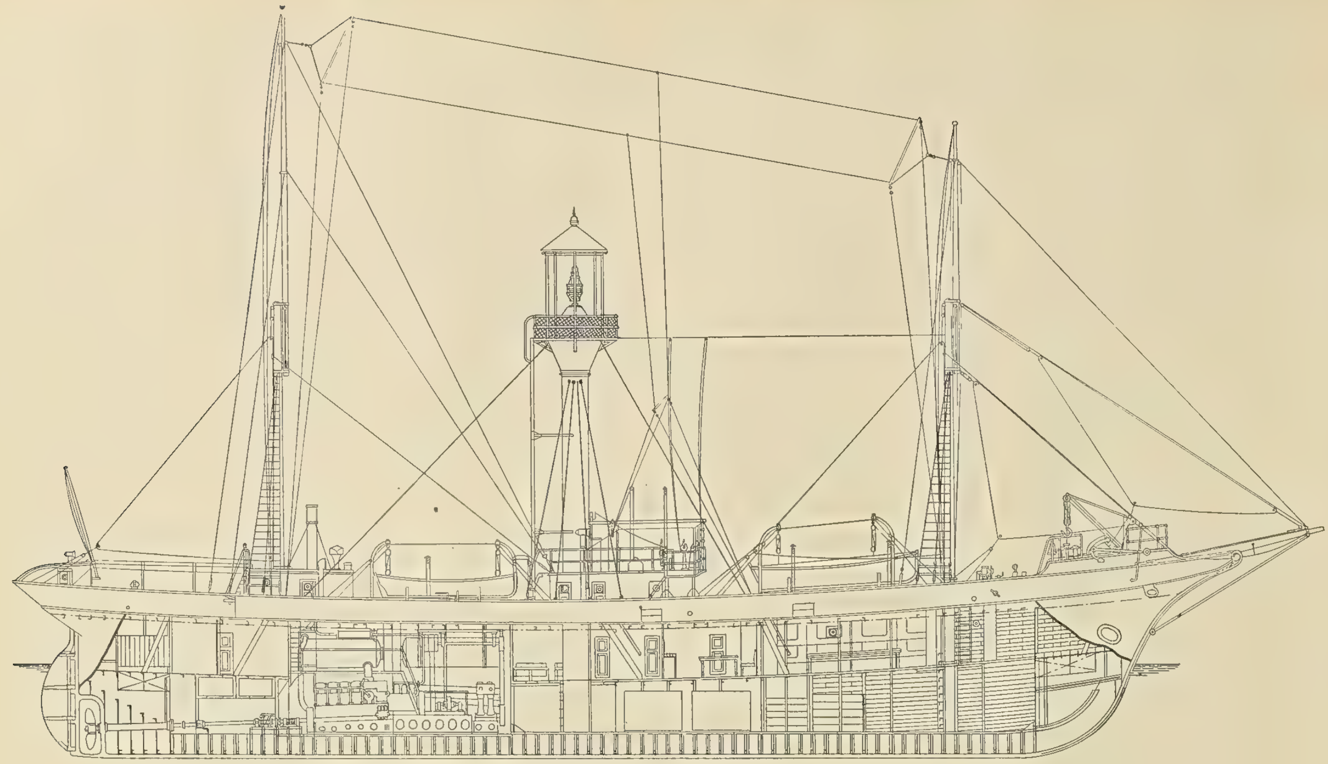
The propelling engine is a direct reversible four-cylinder Sulzer-Diesel of the single-acting, two-stroke type, and develops 220 brake horsepower at 280 revolutions per minute. It was constructed by Messrs. Sulzer Bros. of Winterthur, Switzerland, who, it may be remembered, built the 1,600 horsepower machinery of the Hamburg-South America Company's motor ship *Monte Penedo.* It will be seen from the illustration that the engine is quite self-contained. Its designers have arranged for the driving of the scavenging pump, three-stage air compressor, cooling water pumps, fuel pumps and lubricating oil pumps directly off the main engine crank shaft, or cam shaft, as the case may be.

Starting is by compressed air, which is maintained in cylindrical reservoirs by the second stage compressor. On the upstroke of each piston atmospheric air is compressed in the cylinder to about 450 pounds per square inch pressure; just as the piston reaches the top of the stroke fuel is injected by more highly compressed air through a valve in each cylinder head. The starting and injection valves are operated by a series of rockers and push rods off a cam shaft on the side of the engine. It will be seen that the lower end of each push rod is connected to a small "heel" fitted with a roller running on the cam, the "heel" itself being mounted on a lay shaft carried in bearings just above the cam shaft. By having the lay shaft connected to the control lever it can be given a partial turn, thus varying the timing of the opening of the valves when the engine is reversed. The fuel pumps, four in number, can be seen to the right of the control lever. They are of the plunger type and are operated by eccentrics.

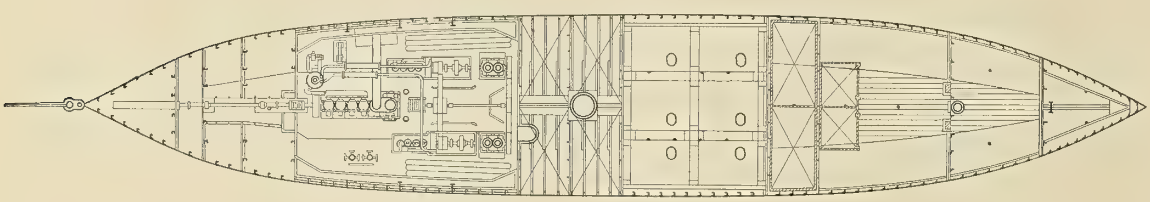
Immediately fuel is injected combustion takes place, and on the down stroke the exhaust port opens, and almost immediately after scavenging air is admitted through another port at the bottom of the cylinder, via the rotary valves from the



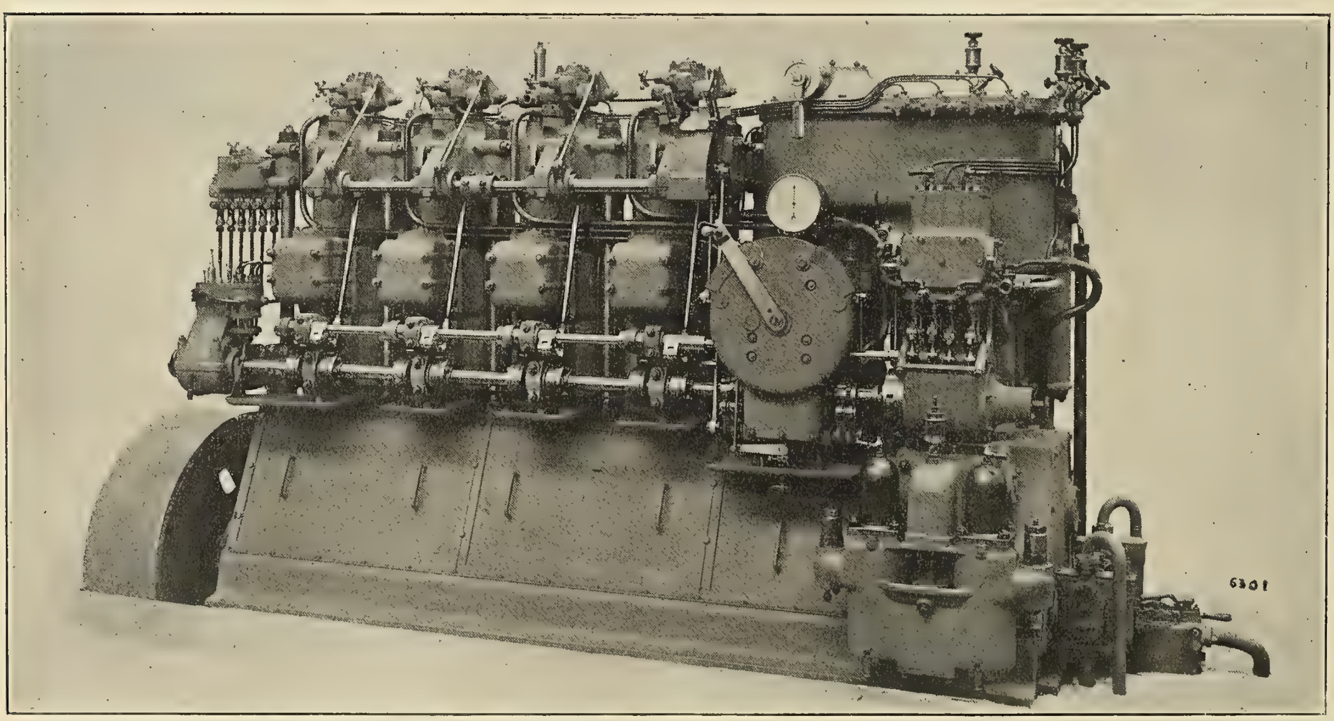
ELBE LIGHTSHIP FITTED WITH A 220-B.H.P. REVERSIBLE SULZER-DIESEL ENGINE



PROFILE



HOLD PLAN



220-B.H P. SULZER-DIESEL ENGINE FOR THE ELBE LIGHTSHIP pumps, and the cylinder is filled with pure atmospheric air. The cycle of operations is then repeated. Each fuel injection valve is fitted with a hand control for regulating the supply of fuel. At the after end of the cam shaft are driven a number of lubricating oil pumps, from which are led pipes to the principal working parts. An interesting feature of the construction is the carrying of the four cylinders on ten massive steel columns bolted to the bedplate and cylinder heads, thus taking away all axial strains and stresses from the body of the cylinders and the crankcase. The latter is of the enclosed type, fitted with three very large steel plate doors on either side. The pistons, by the way, are water cooled, and the water is led through telescopic pipes without stuffing boxes, entering the piston head in the form of a free jet. The power developed by this engine was found on trials sufficient to give the lightship a speed of 9 knots, and no doubt this could be exceeded in the event of an emergency such as a severe gale.

Turning to the auxiliary machinery there are two three-cylinder Diesel motors of the four-stroke type, each developing 35 brake horsepower at 450 revolutions per minute. The after end of each is coupled to a continuous current dynamo for the lighting of the ship and the main lantern, while at the forward end of each is driven a two-stage air compressor for compressing and maintaining air to 220 pounds per square inch for the deck windlass, while by belt off the flywheel is operated another air compressor for supplying air to the fog horn. There is also a single cylinder motor of 6 horsepower turning a two-stage air compressor for charging the main starting reservoirs should the supply run down before the main engine can be got going. There are, of course, accumulators of large capacity as a standby.

Marine Uses of Electric Storage Batteries

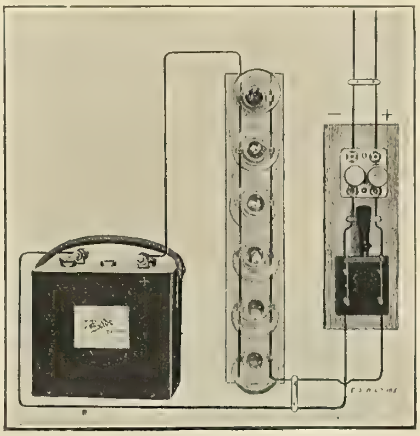
Among the many uses for which electric storage batteries are suitable on board ship the following are perhaps the most extensive and important: For lighting and operating small motors on private yachts, for lighting and engine ignition on motor boats, for propulsion of launches, for gun firing on warships, for stand-by purposes on lightships, for insuring continuity of service in wireless telegraph plants, and, finally, for the propulsion of submarines under water.

Perhaps the most extensive use of storage batteries in marine work is on board private yachts for illumination and operating small motors. Here the battery can be charged during the day from the dynamo while the engine is running, or, if the boat is lying at anchor, charging can be done at any time that is most suitable, and the battery is available for its varied uses when the dynamo and engine are shut down. The battery requires little space and may be placed under the floor or between decks, wherever there is a small amount of available space. The plates of the cells are contained in a specially deep type of rubber jar covered over with a tight-fitting rubber cover. The cells are assembled generally in lead-lined wooden trays. It is evident that small portable batteries of this type would be of particular advantage for lighting on small motor boats. The requirements for a battery for propulsive purposes, however, necessitates a special design which is quite extensively used in boats varying from 18 to 55 feet in length which have a speed of about 5 miles an hour and a considerable radius of action.

A very interesting and important development of storage batteries is furnished in the special application of a three-cell Exide battery, manufactured by the Electric Storage Battery Company, Philadelphia, Pa., for the use of gun firing in the United States navy. Each gun in the vessels thus equipped is supplied with its own battery. The rated capacity is 20 ampere hours when discharging at the 1 ampere rate. In addition to one battery for each gun, each vessel also carries a number of spares, so that the batteries can be released for recharging and yet all guns kept ready for immediate action. The battleships and armored cruisers thus equipped are supplied with a standard charging panel which has been developed by the Bureau of Ordnance. This panel is installed in the electrician's room, and the batteries are taken to that point when they are to be recharged.

Another battery manufactured by the above company, called the iron-clad Exide battery, which is a development of the pasted or Faure type of plate designed for reliability and rugged service, has been selected in recent installations for the United States Lighthouse Department. There has been developed a very high-powered lamp for use on lighthouses and lightships. This light consists of a small 6-volt Tungsten lamp contained in a parabolic reflector usually of from 18 to 20 inches in diameter. The result is that a very powerful beam of light is obtained at an exceedingly low expenditure of energy.

One of the largest and, in many ways, the most interesting application of the storage battery is in the submarine. The first submarine torpedo boat in the United States navy was



EXIDE BATTERY INSTALLATION FOR GUN FIRING

put in commission in 1897. Important advances have been made since then, not only in size and equipment of the boats, but in the special storage battery, which has made the submarine possible. The first boat built, the *Holland,* had in it a battery of 60 cells of the Plante type. Each cell contained 17 plates measuring 23 inches by 15½ inches. The tanks containing these plates were made of steel, and completely covered inside and out by lead sheets. As succeeding boats were built, the type of plate was changed, first to "Manchester Chloride," then to "Manchester Box," and finally to "Exide," which is the type of plate in most general use at the present time. The size of plate has increased to 30 inches by 15 5/16 inches, the number of plates per cell to 27, and the number of cells to 120. The rating of this battery is 2,400 amperes for 1 hour.

The lead-lined tanks were some time ago discarded and a very heavy rubber jar developed. This apparently is the largest size jar ever used in storage battery practice, and has been very satisfactory. The usual method of connecting the plates from jar to jar is that known as the tandem method. With this scheme, each corresponding positive and negative plate in joining jars is burned to a lead-plated copper conductor bar. This makes it possible to easily remove the plates from the jars, and facilitate cleaning. The cells are placed in the lower part of the boat, removable hatches being placed over the battery.

There are at the present time about twenty-five of these submarines in commission, and in all probability within a comparatively short time this number will be doubled.

E. L. REYNOLDS.

New Steamers for Chesapeake Bay Service

The Maryland Steel Company, of Sparrow's Point, Md., recently completed and delivered to the Baltimore, Chesapeake & Atlantic Railway Company two modern side-wheel steamboats, the *Dorchester* and *Talbot,* for night service on Chesapeake Bay and tributaries, equipped to accommodate 400 passengers.

These vessels are the latest development of this type of boat as far as increased accommodations are concerned. The patented Isherwood system of longitudinal framing was decided on for a reduction in weight and the necessary rigidity. Over the one-knot Kent Island course, maintained by the builders, the *Talbot* made an average of 14½ miles per hour in three runs.

The length of the boats over all is 200 feet, the length between perpendiculars 192 feet, the molded beam 36 feet, the beam over guards 59 feet 6 inches, and the molded depth 11 feet. The specified draft of the boat ready for service was 6 feet 6 inches, mean.

FIG. 1.—ISHERWOOD FRAMED, SIDE-WHEEL STEAMER DORCHESTER

General Arrangement

The crew, waiters, cooks, firemen and chambermaids are located on the lower deck. Accommodations are also provided for first and second class, white and colored passengers on this deck, with a second class smoking room just forward of boiler room. At the forward end of main deck are located the toilets for crew and second class passengers. Abreast the casings at the sides of the boat are located the office, mail room, package rooms, ice house and storerooms. The galley is located at the after end of the engine casing. At the after end of the main deck there are eight staterooms, a wash room, barber shop and smoking room. On the saloon deck are two bedrooms with private baths, forty-five staterooms, the purser's stateroom, the dining saloon, pantry and lounging room. Separate toilets are provided for white and colored passengers. On the gallery deck are thirty staterooms, the pilot house and officers' quarters.

All joiner work is of white pine. The finish of the smoking room is in hardwood, and all finish of berths, etc., is also of hardwood. The floors of the dining room, pantry, toilets, lounging and wash rooms on the saloon deck and the floor of the forward part of the saloon deck in the cabin in line with the forward staterooms, are covered with interlocking rubber tiling, while the floors in the barroom, washrooms and toilets on the main deck and in the galley and cooling room are covered with asbestolith. The treads of the main stairs are covered with rubber.

A McCune Howell vacuum cleaning apparatus, large enough to operate two sweepers simultaneously, is provided, capable of supplying 70 cubic feet of fresh air displacement at the vacuum producer per minute. The vacuum producer is controlled by an automatic regulator which can be adjusted to suit requirements.

The vessel is heated throughout with steam and lighted with electricity. Running water is fitted to all rooms. Adequate fire mains and hose are installed, and sufficient lifeboats and rafts to carry all of the passengers and crew are provided.

Main Engines

The machinery for these ships is of novel design. The main engine is of the two-cylinder, inclined, surface-condensing type, with Corliss valves, having cylinders 30 inches diameter by 8 feet stroke. This type was adopted because of the economy and ease of operation, and also by the saving of the valuable space usually occupied by the gallows frame, walking beam, etc., of the old beam engine. The main bearings rest directly upon the cast iron condenser shell, and are connected to the cylinders by wrought steel thrust rods or braces. These rods are of rectangular section near the cylinder end and form the crosshead guides. They are supported at about mid-length by forged steel stanchions; these stanchions rest upon a cast iron bedplate.

The cylinders are lagged separately, bolted together, and rest on an inclined plate and angle foundation. The valves are of the Corliss type and work in separate hard cast iron working liners. The valve gear is of the Corliss type, similar to regular stationary plants, with wrist plates, dash pots, releasing gear, etc. The reversing is effected by means of a set of Stephenson links, which are controlled by a steam ram located on the bedplate. The connecting rods are 17 feet 6 inches between centers, of the forked type, with brass boxes having bolted connections at both ends. The piston rods are 8 inches diameter and hollow. They pass through the back heads and form tail rods, which are supported by cast iron slippers with adjustable brass shoes. The crankshaft is 11½ inches diameter in the bearings, the inboard webs for each cylinder having loose pins and brass gibs similar to the arrangement employed on beam engines. The cranks are set at 90 degrees to each other.

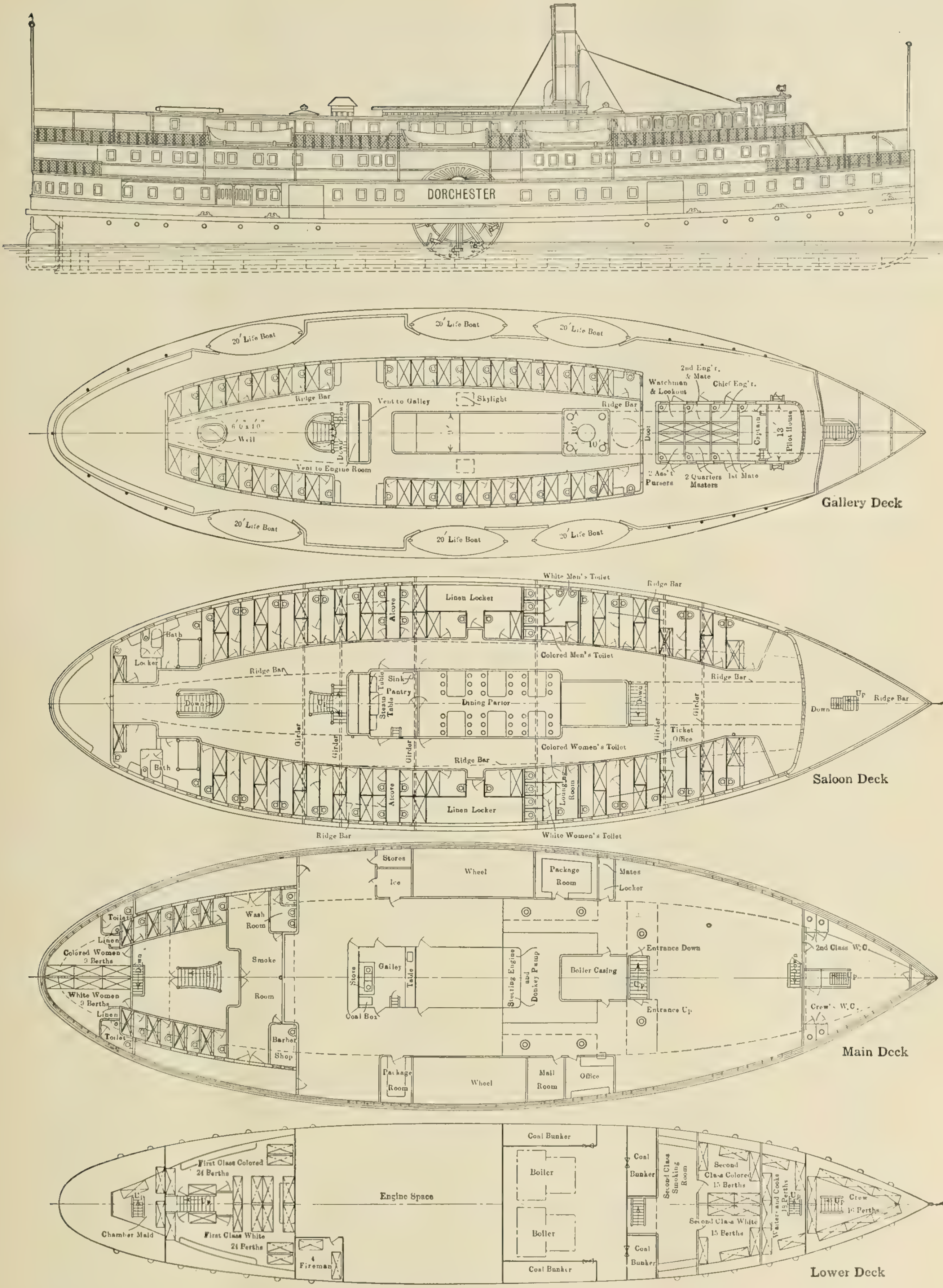


FIG. 2.—PROFILE AND DECK PLANS OF DORCHESTER

The main air pump is of the bucket type, and is driven from the starboard crosshead by steel plate arms and steel rods, the rock shaft being carried by the bedplate. A copper bilge pump is also driven by the air pump crosshead.

The main throttle valve is common to both cylinders, and is operated by levers and rods from the working platform, which is in the lower engine room just outboard of the starboard cylinder. The handling gear stand also supports the reverse lever and a lever which regulates the cut-off trip gear, thus abolishing the old beam-engine style of operating the main valves by hand when the engine is running in the astern direction.

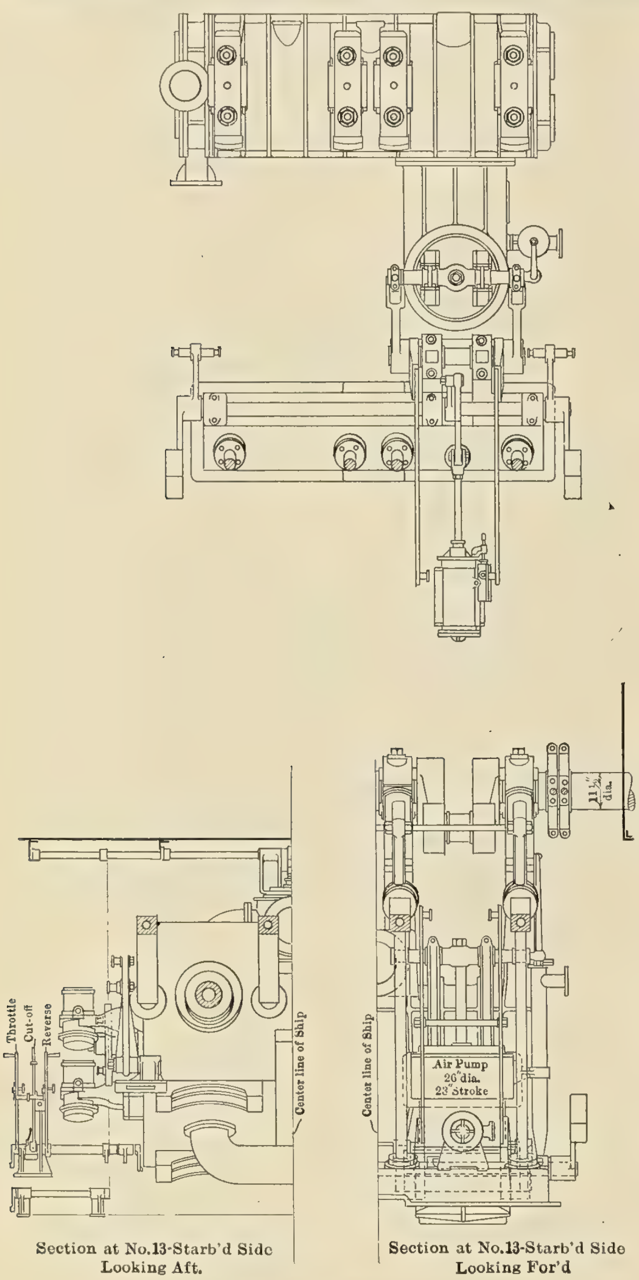


Fig. 3.—Sectional Views of Dorchester's Engine

The wheels are of the feathering type, 19 feet 4½ inches diameter, each having 10 oak buckets, 8 feet 6 inches long, 3 feet wide and 3¾ inches thick. The arms and rims are of double, refined iron with cast steel fittings.

Boilers

There are two boilers of the water-leg type, 10 feet 1 inch diameter by 13 feet 9 inches long, built for 90 pounds per square inch working pressure. The tubes are 3½ inches diameter, and are 10 feet 7½ inches long. The total heating surface is 3,220 square feet, and the total grate surface 114 square feet. The steam chimney is 8 feet diameter by 12 feet long, with a 57-inch diameter corrugated flue. The boilers are fitted with feed circulators and flue blowers.

Auxiliary Machinery

All the auxiliary machines are located in the lower engine room, and consist of the following: One 10-inch centrifugal circulator, driven by a vertical single-cylinder steam engine, one 10-inch, 7-inch by 12 inch simplex feed pump, one 12-inch, 7-inch by 12-inch simplex donkey pump, one horizontal simplex sanitary pump, one horizontal simplex fresh water pump, two double tube injectors, a steel plate filter box and a 25-kilowatt, 110-volt electric generator, driven by a vertical single-cylinder steam engine. The vacuum cleaning plant is also located in the lower engine room.

The arrangement and material of the piping throughout are of the highest class, all the main steam and exhaust, circulating, feed and escape piping being of copper.

These boats have been in service about six months and the machinery has proved entirely satisfactory in every respect.

An Oil Driven River Vessel

It is appropriate that the British Petroleum Company should decide upon adopting the use of oil for propelling the vessels used in its service so far as practicable, and some particulars of a new 150-ton oil-carrying barge which was recently placed in service on the River Thames for that company will therefore be of interest.

The vessel, which was named *White May*, was built at the Hubertina Works, Veerpolden, Haarlem, and was towed over to England during very rough weather. She is 105 feet in length by 17 feet 9 inches beam, with 6 feet molded depth and 4 feet 9 inches draft on a displacement of 150 tons. Her normal carrying capacity is 100 tons, but if necessary she can take 130 tons aboard with safety. She is steel built of 5/16-inch plating throughout, and the hull is divided into three compartments by bulkheads. Forward is the forecastle fitted with folding bunks, table, stove, etc., for the crew, while aft of this space is the hold having two splash bulkheads. On deck there is a 4-inch iron pipe running the length of the hold, which is used as a suction and delivery system for emptying or loading the cargo. There are two connections to the pumps ashore and three to the hold, the latter being fitted with large screw-down valves. This piping is of sufficient capacity to allow the boat to be emptied in an hour.

Aft of the hold is the engine room, which contains a two-cylinder Kromhout motor installed by Messrs. Perman & Co., Ltd., of London, consuming kerosene (paraffin) as fuel and driving a solid propeller through an epicyclic reverse gear. The cylinders are 11 13/16-inch bore by 14 15/16-inch stroke and 76 brake-horsepower is developed at 265 revolutions per minute on a fuel consumption of 57 pints per hour, or .75 pint per horsepower hour. Under a full load of 100 tons the barge has attained a speed of 7.35 knots, her designed speed being 7.25 knots. Regarding the engine, the following points of interest may be noted: Starting up is effected by petrol, and on each cylinder there is a small brass container which contains just sufficient spirit for the engine to run until the vaporizing plate over the exhaust valve is heated, when the change over automatically takes place. The petrol is fed to the containers from a small tank on deck, and is cut off immediately the required quantity has entered the afore-mentioned containers, so that there can be no danger of fire or explosion from using the lighter fuel. Lubrication is by sight drip-feed, the lubricators being fed from a brass reservoir over the engine. Governing is on the hit-and-miss principle,

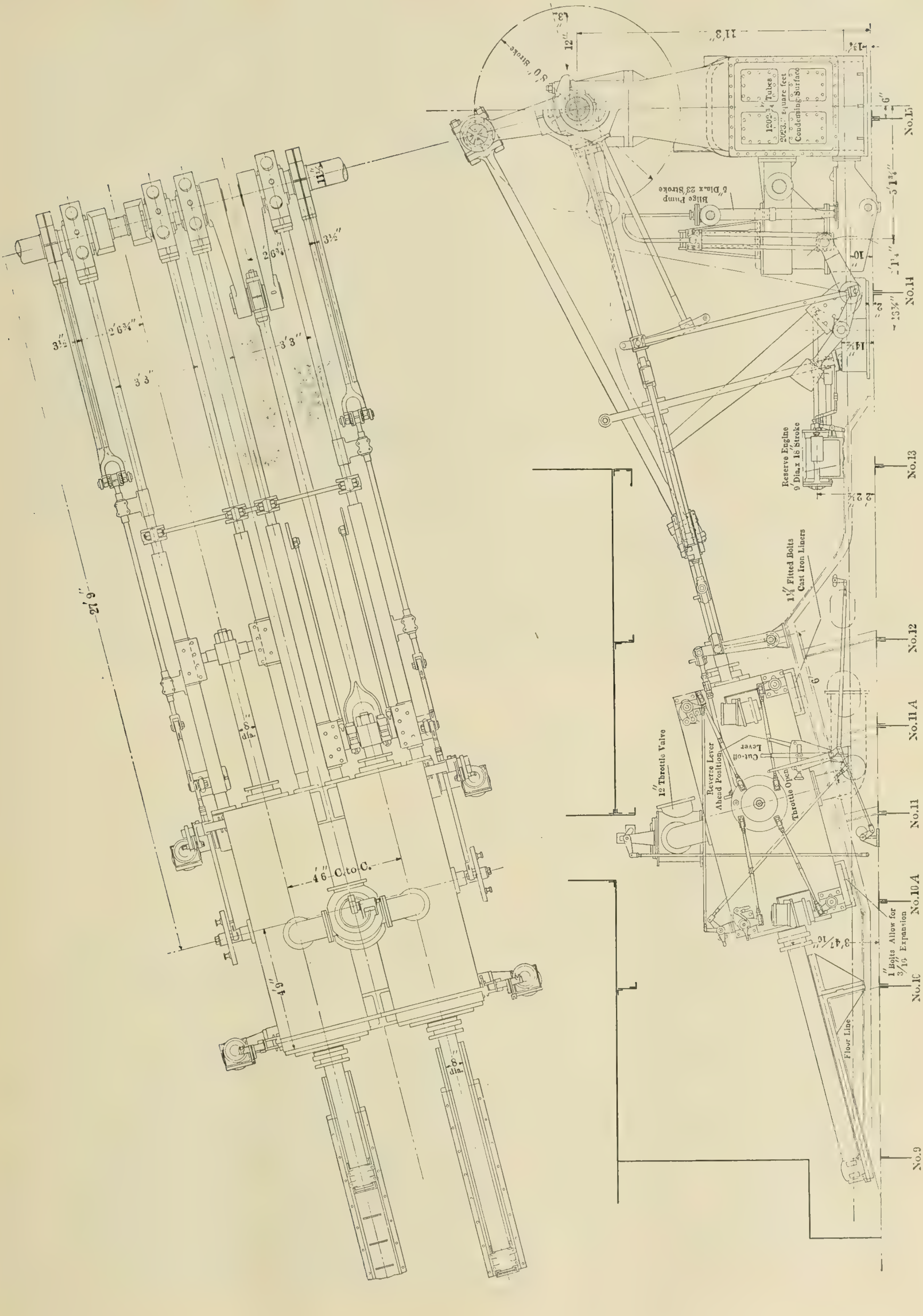


FIG. 4.—TWO-CYLINDER, INCLINED ENGINE FITTED WITH CORLISS TYPE VALVE GEAR FOR SIDE-WHEEL STEAMER DORCHESTER

the inlet valve being automatic, so that the action of the governor is to keep the exhaust valve closed when the engine exceeds normal speed. The cooling water is carried direct into the exhaust pipe, the water being automatically cut off under the action of the governor. Circulation is maintained by a centrifugal pump driven by friction off the inside rim of the flywheel. To prevent back suction when the engine is stopped, the water is first cut off and the exhaust pipe emptied. Ignition is by Bosch plugs, the current being derived from two "flicking" or trip-drive low tension magnetos. On the top of each cylinder there is a connection to a small tank, which stores compressed air, etc., for the siren. The reverse lever is carried through the deck to the steering wheel over the engine room. By the wheel, which is situated aft, there is a small lever which controls the speed of the engine, so that under ordinary running conditions a man is not required below. There are two drum fuel tanks in the engine room, each with a capacity of 250 gallons.

Steel Harbor Lighter Willard U. Taylor

The new steel harbor lighter *Willard U. Taylor*, shown in Figs. 1 and 2, has just been placed in service by the Undercliff Terminal & Warehouse Company in New York harbor. The lighter was designed by Messrs. Cox & Stevens, of New York, and built under the supervision of this firm at the works of J. H. Dialogue & Son, Camden, N. J. The principal dimensions of the lighter are: Length over all, 110 feet; beam, 30 feet; molded depth, 12 feet.

This lighter possesses a number of points that are unusual in vessels of her type and seems a decided improvement upon existing vessels. The hull is constructed of steel throughout of exceptionally heavy scantling, with a view to securing the strongest and most lasting structure that can be produced. The machinery is placed as far aft as possible in order to secure a large forward hold, and also to leave the forward deck unencumbered. As will be seen from the photograph and drawings, the upper deck is carried out to the sides of the vessel for the full length, thus providing permanent protection for cargo. The quarters for the crew are situated on the upper deck, and as the hoisting engine is located in the forward hold, the result is that the entire deck space from stem to stern, with the exception of the engine and boiler inclosures, is free for the stowage of freight, thus giving unusual cargo capacity for the dimensions of the lighter.

FIG. 2.—HARBOR LIGHTER WILLARD U. TAYLOR

Steam is supplied by a leg-type boiler at a working pressure of 150 pounds per square inch to the main engine, which is of the inverted single-cylinder, direct-acting type, with a cylinder 20 inches diameter and 26 inches stroke. The lighter is heated by steam, and is equipped with a heavy wood spar and derrick boom for handling cargo. A powerful hoisting engine is located in the hold.

Without overloading the lighter can carry 300 tons, and her arrangements for carrying cargo are so well worked out that her load can be taken on or discharged by her own power in a minimum amount of time.

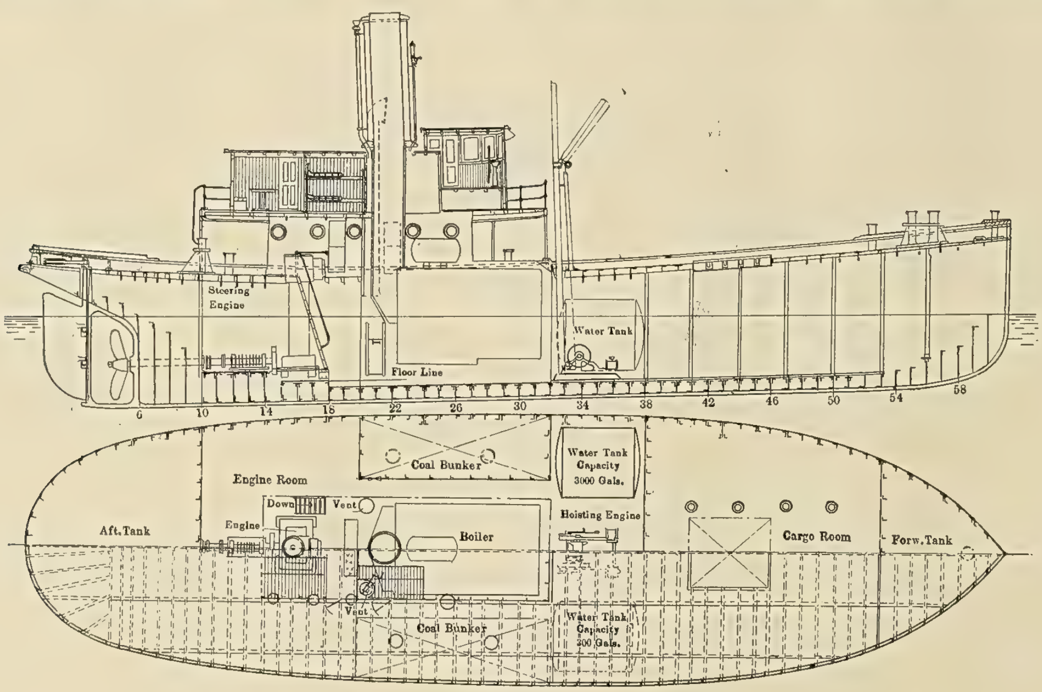


FIG. 1.—GENERAL ARRANGEMENT OF LIGHTER

Motor Yacht Equipped with Diesel Engines

A vessel which should be of special interest to the yachting world is the *Idealia,* recently designed and constructed by the Electric Launch Company, in Bayonne, N. J. The *Idealia* enjoys the distinction of being the first yacht built in America to be equipped with engines working on the Diesel principle.

The *Idealia's* principal dimensions are: Length, 84 feet; beam, 14 feet; mean draft, 4 feet. A recent test showed her metacentric height to be 2 feet, which is considered very satisfactory, as it combines ample stability with seagoing qualities. The model is the same as that recently brought forth by the Electric Launch Company in its designs of 84-foot cruisers, and combines lines which make her easy to drive and at the same time with a comparatively broad beam, to give ample room for comfortable quarters for the crew, owner and guests.

A comfortable crew space is located in the forecastle. Abaft of this is the dining saloon with ample seating quarters for a party of eight. The galley is located abaft the dining saloon and extends the full beam of the ship. The engine room occupies a comparatively small portion of the length of the vessel, and is located immediately abaft the galley, being entirely separated therefrom by a watertight bulkhead. In addition to the main engine, which is a 150-horsepower reversible American-Nuremberg heavy oil Diesel motor, the engine room contains a 10-horsepower auxiliary engine, direct connected to a 5-kilowatt generator and an auxiliary air compressor. Tanks for the storage of fuel oil and lubricating oil are built in the sides of the engine room. Thus the entire motive power is contained in a comparatively small space, and yet leaves ample room for the crew and operation of the machinery. The owner's stateroom is located abaft the engine room, and extends the full width of the vessel. Access to the living quarters is obtained by means of the hatchway on the starboard side leading from the spacious lobby on the same side of the vessel. This lobby is immediately abaft the owner's stateroom, and doors open from it into that room as well as into the bathroom and the guests' stateroom, which extends across the ship abaft the lobby. In the after compartment

FIG. 1.—MOTOR YACHT IDEALIA, THE FIRST AMERICAN YACHT TO BE EQUIPPED WITH DIESEL ENGINES

FIG. 2.—DECK VIEW

FIG. 3.—MAIN SALOON

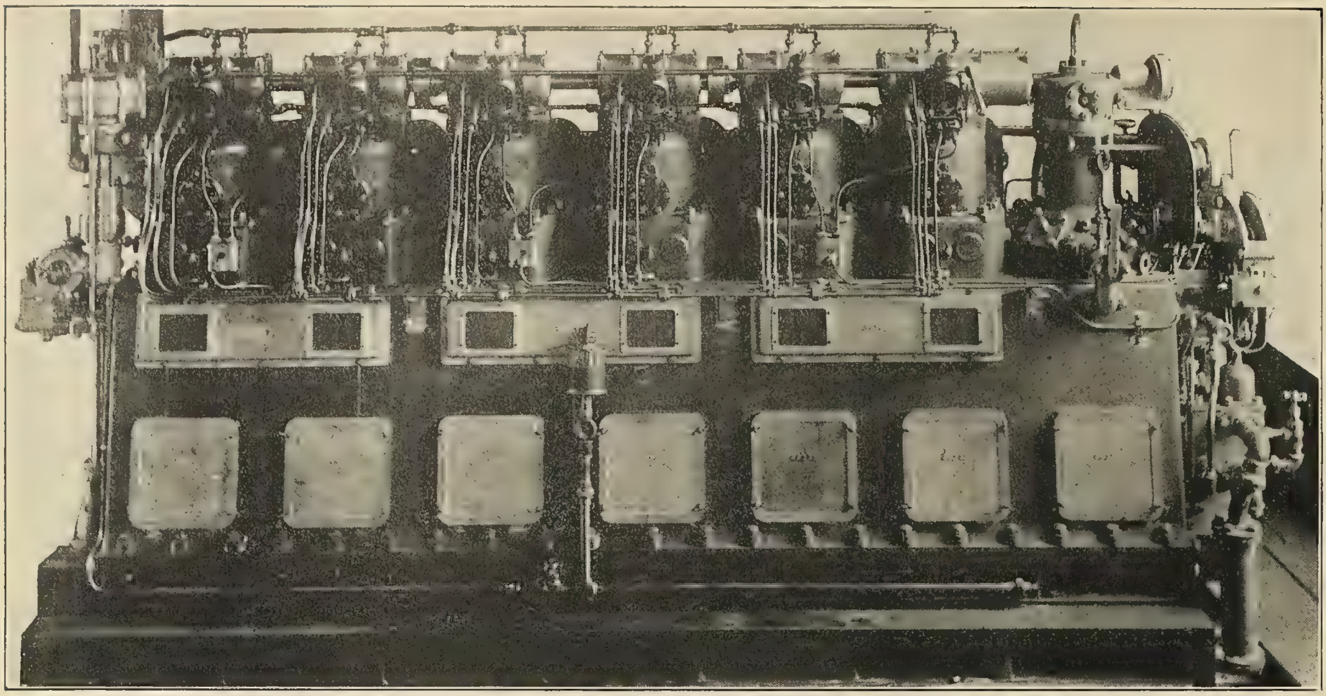


FIG. 4.—SIX-CYLINDER, 150-HORSEPOWER AMERICAN-NUREMBERG ENGINE INSTALLED ON THE IDEALIA

space for storage is provided, and in this compartment is also located a large storage battery, to be used as an auxiliary to the lighting system. The boat is finished throughout in bright mahogany and all fixtures and furnishings are of pleasing design.

There is a deck house forward over the dining saloon, with the steering station amidship immediately abaft. The *Idealia* is rigged with a pole signal mast, located between the deck house and the smokestack. The smokestack is comparatively large in diameter and, while not required for the type of engine employed, gives to the vessel the symmetrical appearance usually met with in yachts of this character. The smokestack serves a number of purposes—containing a muffler for the engine, the smokestack from the galley, and in addition serving as an engine room ventilator. Two boats are carried on deck abaft the smokestack. The anchor gear consists of an Elco electric capstan, with electric control located on deck. A powerful searchlight is mounted on the forward part of the deck house.

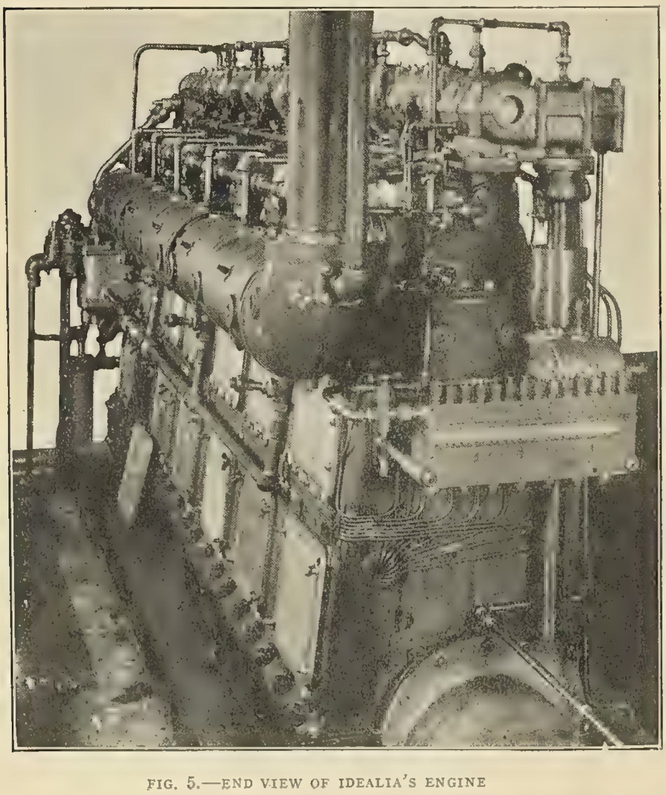


FIG. 5.—END VIEW OF IDEALIA'S ENGINE

The *Idealia's* engine is of the Nuremberg type, built by the New London Ship & Engine Company, Groton, Conn., and consists of six cylinders and one two-stage air compressor. It works on the two-cycle principle, and therefore has an even turning moment and does not require the use of a flywheel. A very efficient patented system of reversing is provided, whereby through the operation of a single lever the engine may be started, stopped and reversed with greater ease and quickness than are usually found in a steam engine of the same power. The maneuvering of the engine is accomplished by means of compressed air contained in steel flasks. With the supply of air carried the engine has been reversed over forty times in quick succession. In addition to the store of compressed air an auxiliary air compressor is provided, independently driven by a 10-horsepower oil engine, which may be started by hand, so that all danger of being unable to start the engine, due to lack of compressed air, is practically eliminated.

With the Diesel engine low grades of oil may be efficiently used and the thermal economy is very high. This gives the engine a great advantage over the gasoline (petrol) engine for units of this size and larger where the fuel bill is a serious item. An excellent way to appreciate this feature is to look into the question as it affects the *Idealia*. The *Idealia's* engine develops 150 horsepower at 550 revolutions per minute. The fuel consumption averages one-half pound per horsepower-hour, and the fuel oil costs from 3 to 5 cents (1½ to 2½d.) per gallon, depending upon the grade and the place where it is purchased. A gasoline (petrol) engine of corresponding power will use approximately 1 pint of gasoline (petrol) per horsepower-hour, the present price of gasoline (petrol) being about 18 cents (9d.) per gallon. At full power the *Idealia* makes about 14 miles per hour. From the foregoing data it is apparent that, using fuel oil, the radius of action of the *Idealia*, whose fuel tanks have a capacity of 450 gallons, is 630 miles, and the cost of fuel is only 2.167 cents (1.08d.) per mile. If gasoline (petrol) were used the *Idealia* would be able to travel only 336 miles, and the cost would amount to 24 cents (1s.) per mile. In other words, taking gasoline (petrol) at 18 cents (9d.) per gallon, and fuel oil at 3 cents (1½d.) per gallon, the fuel bill of the *Idealia* will be only about one-tenth of a similar yacht equipped with gasoline (petrol) engines. The first cost of oil engines is naturally considerably greater than that of gasoline (petrol) engines. The difference in cost, however, can soon be made up by the saving in fuel bills for the distance traveled. The New London Company is now building a large number of engines of the same general type, ranging from 300 to 900 horsepower, and has plans available for various classes of oil engines of much greater power. Now that a start has been made with the use of Diesel engines for yacht purposes in this country, it is very probable that we shall soon see its extensive adoption in yachts of all sizes.

New Turbine Steamer for the Allan Line

The new turbine steamer *Alsatian* was built by Beardmore, Glasgow, for the British-Canadian service of the Allan Line Steamship Company. The turbines are of the Parsons impulse type, four shaft triple expansion, and the ship is propelled by four three-bladed propellers, each 10 feet in diameter. The chief particulars and dimensions of the ship are:

Length over all	595 feet.
Length between perpendiculars	570 feet.
Breadth molded	72 feet.
Depth	45 feet 6 inches.
Draft	28 feet 6 inches.
Displacement	25,000 tons.
Deadweight	3,000 tons.
Tonnage, gross	18,000.
Shaft horsepower	19,000.
Speed	19 knots.
Number of lifeboats	40.

On the port outer shaft there is one high-pressure turbine 7 feet 6 inches in diameter, and on the starboard outer shaft there is one intermediate-pressure turbine 8 feet 6 inches in diameter, while on each of the two inner shafts there is one low-pressure ahead and astern combined turbine 12 feet in diameter. The steam from the boilers passes into the high-pressure turbine, then over into the intermediate turbine, and afterwards through separate pipes into each of the low-pressure turbines. The exhaust steam goes direct into two steel plate condensers, placed at the after end of the low-pressure turbines.

The introduction of the intermediate-pressure turbine provides a much wider range for the expansion of the steam, and will effect a marked improvement in steam consumption as compared with the usual arrangement of turbines adopted in large merchant steamers and warships. The turbines and condensers are situated in one watertight compartment, together

ALLAN LINER ALSATIAN: DISPLACEMENT, 25,000 TONS; GROSS TONNAGE, 18,000; SHAFT HORSEPOWER, 19,000; SPEED, 19 KNOTS with the main circulating pumps, dual type wet and dry air pumps, evaporators and distillers. The circulating pumps and air pumps form two separate sets, each working in conjunction with one condenser, but they are also arranged so that either set of pumps can work in conjunction with both condensers.

The turbine rotors are built up of steel forgings and the casings are of cast iron, each in two sections with a horizontal coupling.

The propeller shafting is of ingot steel 12 inches in diameter. A torsion meter is fitted to each shaft, indicating the shaft horsepower.

The boiler installation consists of six double and four single-ended boilers, each 16 feet 9 inches in diameter, the double-ended being 22 feet long and the single-ended 11 feet long. They are designed for a working pressure of 200 pounds per square inch and are constructed for the Howden system of forced draft, the air supply being maintained by an installation of electrically driven fans. The furnaces are of the suspension type, the total number being sixty-four. The exhaust gases pass away through two smokestacks, each 50 feet long and 18 feet in diameter.

Coal bunkers are provided at the sides of the boiler rooms, and there are also cross bunkers. The total bunker capacity is 2,500 tons.

The vessel has been constructed to the rules of the British Corporation for the highest classification of that society. She has eight decks—orlop, lower, main, upper, shelter, bridge, promenade and boat decks. The main deck is watertight. There are ten watertight bulkheads subdividing the ship, and they are watertight up to the underside of shelter deck. A cellular double bottom is fitted from the fore peak to the after peak bulkhead. The space between the outer and inner bottom is fitted to provide for 1,800 tons of ballast, 500 tons of fresh water for the ship's use and 400 tons of fresh water for boiler feed reserve. The keel is of the flat plate type and consists of two plates, each 1 inch thick. The shell plating ranges from ⅞-inch at midships to ⅝-inch at the bow and stern. The plating is for the most part double riveted. The after framing is bossed out around the propeller shafting, the shaft brackets being of the spectacle type. The stern is overhung for a length of about 80 feet—that is, the deadwood has been cut away. She has a round stern of the usual warship form, and the rudder is of the balanced type and hung from one pin on the stern post casting. The rudder is of cast steel in two sections, bolted together, and the rudder stock is 18 inches in diameter.

The steam steering gear is supplied by Messrs. Brown Bros., of Edinburgh, and is of the well-known rack and pinion type with auxiliary steam and hand gear. The gear is placed on the lower deck and is controlled from the bridge by telemotor gear.

The ship has two steel masts 30 inches in diameter, with four derricks on each mast. Marconi telegraph wires extend from masthead to masthead, and there is a Morse signal lamp on the fore mast truck. Lifeboats are provided for all on board. Sixteen wood lifeboats and eighteen semi-collapsible boats are stowed under davits, while six semi-collapsibles are stowed within reach of the derricks aft. The davits are of the ordinary pattern, but of steel tube, and the davit blocks are of Higginson patent non-toppling type. For hoisting and lowering the lifeboats, four electric winches are placed on the boat deck.

Ten silent-running steam winches of Wilson's patent are on deck for working the cargo. These winches have cylinders 8 inches by 12 inches, and are each designed for raising a load of 5 tons.

Stockless anchors, each 6½ tons, are stowed in cast iron hawse pipes, with chain cables of 3-inch stud links. There is one capstan and windlass for each cable. They are of Napiers make and each is worked by a vertical engine having a cylinder 18 inches diameter with 12-inch stroke. At the stern four warping capstans of Napiers type are placed on the shelter deck. Each one is driven by a vertical engine with 12-inch cylinder and 10-inch stroke. Three of Waygood's electric lifts are provided for passengers, stores and mails.

The *Alsatian* is fitted throughout with the Magneto Company's electric clock system, which consists of a number of Magneto secondary clocks distributed throughout the ship, all actuated by a centrally placed Magneto marine master clock.

For the 1,550 passengers and 575 members of the ship's staff there is excellent provision in the form of staterooms and saloon accommodation on the various principal decks, and there is also liberal provision for promenading and recreation. On the boat, or top, deck the clear stretches of deck afford a very fine run promenade. On the deck below there is the main promenade, sheltered from the sun, and also from the rain, by sliding windows forward, while there is another sheltered promenade on the deck below this.

The characteristics of the *Alsatian's* accommodations are space, air, light and ventilation. The Allan Line, after long experience, have adopted the Ashwell & Nesbit system of ventilation. The first class staterooms are arranged so that they can be booked separately, and many of the staterooms are connected so that they can be booked in series for families. In a number of staterooms only single berths are provided, and the great majority of the rooms are only for two passengers.

The various public apartments in the *Alsatian* are elegant in design and admirable as regards dimensions and proportions, the general scheme of decoration being chaste and subdued, the upper rooms, such as the reception hall, the lounge and the library being unconventional in respect of having bay windows and alcoves, which impart a general feeling of shore environment and comfort.

The *Alsatian* is designed to carry her cargo in five holds. The provision made for carrying perishable cargo is the feature of greatest interest in her cargo arrangements. The insulated holds are at the stern. The refrigerating machinery is supplied by the Liverpool Refrigeration Company, and consists of two compound duplex CO_2 machines, driving two double-acting CO_2 compressors, and each machine is capable of maintaining a temperature of 15 degrees F. in the insulated holds, which have a total capacity of 80,000 cubic feet. Air cooling is now being adopted when the maintenance of flavor is an important consideration, and for the transport of cheese, butter, apples, etc., 30,000 cubic feet of cargo space is fitted with brine pipes, while air drawn from the atmosphere is driven over the pipes by an electric fan, which supplies cool air at 15 degrees F. The brine is circulated on the cloud system by the horizontal duplex brine pumps.

The electrical installation of the *Alsatian* consists of three turbo-generators of 250 kilowatts each, placed in one compartment on the lower deck, and these have been supplied by the British Westinghouse Electric Company.

The doors in the main hold bulkheads have been fitted with the Stone-Lloyd system of closing, whereby they can all be closed in a few seconds from the navigating bridge. This system is worked by hydraulic power, two pumps being fitted in the main engine room for the purpose. From the pumps a pressure main pipe is led to a hydraulic cylinder fitted at each door. An automatic indicator is placed on the bridge and shows the position of each bulkhead door, whether closed or open.

The vessel is fitted with receiving apparatus for submarine signals on the system introduced by the Submarine Signal Company. She has also a 24-inch searchlight on the bridge.

The *Alsatian* is designed for a speed of 19 knots at sea.

McAndrew's Floating School

BY CAPT. C. A. McALLISTER*

"I suppose you have noticed that toy safety valve just over the uptakes on our boilers. If you didn't see the main safety valves, you might get the idea that the boiler designer had put a boy to do a man's work. The object of this little valve, which should always be a lever valve with a sliding weight, is to give warning that the steam is almost up to the blowing-off point; hence it is known as a sentinel valve. If for any reason the springs in the safety valve refuse to work, this little valve is sometimes very useful.

"You, of course, have heard of the blow valves on the boilers. These are usually fitted to all boilers; one is known as the 'surface blow' and the other as the 'bottom blow.' In boiling water the lighter impurities, such as grease and other substances which float on water, are driven to the surface of the water. O'Rourke, I know, has often watched his mother skim the grease off the top of the boiling pot of soup, when he was a boy and was so hungry he could hardly wait for dinner time. The idea of the surface blow on a steam boiler is about the same, only in a boiler there is a pipe connecting the blow valve to what is known as a 'scum pan,' usually located in about the center of the boiler and at about the low-water level. At intervals it is advisable to open the surface blow valve and give it a slight blow in order to remove the grease and other floating impurities from the boiler water.

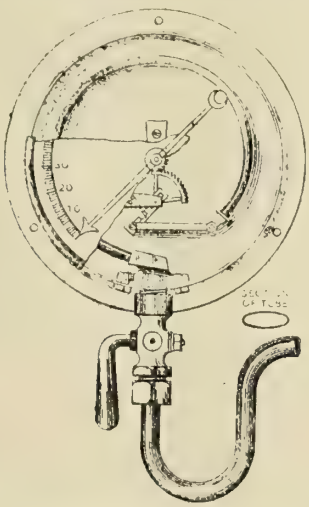


FIG. 3.—BOURDON STEAM GAGE

"The bottom blow valve is located at the lowest part of the boiler, and there is usually a perforated iron pipe connected to the blow valve. Mud and heavy impurities collect at the bottom of the boiler, and an occasional blow will remove such substances. This bottom blow is sometimes used to pump out the boiler when it is desired that it be emptied.

"One of the most important of the so-called 'boiler fittings' is the steam gage, for it is by means of this instrument that we are enabled to determine the actual pressure of the steam in the boiler.

"Fig. 3 is a picture of the type of steam gage usually fitted to marine boilers. By means of a circular tube having an elliptical section as shown, when the pressure is applied to the inside of the tube it tends to assume a round section, and the tube itself tends to straighten out owing to the greater area subjected to pressure on the outside surface. The free end of the tube is connected by gear wheels and pinions to the needle on the face of the dial which, when properly adjusted, records the steam pressure. Remember, as I have called to your attention before, boiler gages only record the pressure above the atmosphere and not the absolute pressure.

"Steam gages on boilers should be tested at intervals to see that they are adjusted correctly, as it frequently happens that gages on different boilers, all connected up, show a variance of from 1 to 10 pounds. I once had a green fireman with me who nearly broke his back trying to get the steam on his boiler up to the same pressure carried by the other boiler; as a matter of fact, the gage on his boiler recorded 5 pounds less pressure, due to its being out of adjustment. The older firemen let him hustle for a day or so before they told him the gage was wrong."

"Why do they always put that crook in the pipe to the steam gage?" inquired Nelson.

"That's because most water tenders are so used to seeing snakes that they want things to look natural to them when they watch the steam gage," volunteered O'Rourke.

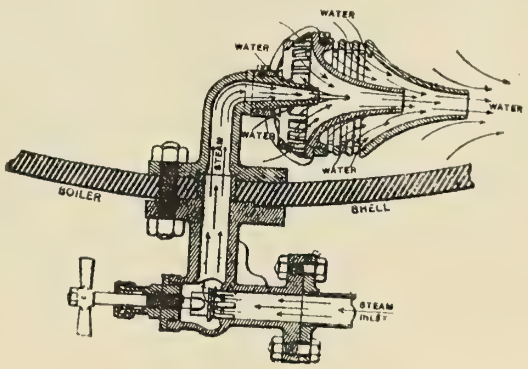


FIG. 4.—HYDROKINETER

"O'Rourke is as nearly right as usual," replied McAndrew. "The real reason is that if the steam acted on the Bourdon tube direct, the expansion due to the varying temperatures would make it record inaccurately. Hence, the crook serves the purpose of a trap, as it fills with water by the condensation of the steam, and this water is forced into the tube by the steam.

"Another important fitting is the air cock, which is usually placed at the highest part of the boiler. When fires are started this cock should be opened in order that, as the steam is raised, all the air in the boiler will be driven out. It should not be closed until live steam issues from the cock.

"To impress upon you the importance of paying attention to even the smallest details around boilers under steam, I want to call your attention to a boiler explosion on board an American vessel not many years ago, when over thirty lives were lost and great damage was done because a fireman who was sent on top of the boilers to close the air cock not only closed that fitting but also shut off the cock in the small steam pipe which led to the steam gage. The result was that although no steam showed on the gage the pressure in the boiler rose to the bursting point and the explosion followed. Always remember that if you make a mistake like that you endanger not only your own life but the lives of everybody else on the ship.

"Some boilers are fitted with what is known as a 'hydrokineter,' which means literally a water heater.

* Engineer-in-Chief, U. S. Revenue Cutter Service.

"One of the great faults of all Scotch boilers is that the water under the furnaces and combustion chambers does not circulate properly, or, in other words, it is dead. The hydrokineter is usually located in this dead water, and when live steam is admitted it acts on the principle of an ejector and causes the water to circulate as indicated by the arrows in the sketch. I have seen boilers carrying over 100 pounds of steam when you could bear your hand on the bottom of the shell because of the presence of the dead water underneath the furnaces. Some engineers when raising steam will connect the auxiliary feed pump so as to draw this cold water out through the bottom-blow connection and discharge it through the auxiliary feed check valve, thus causing an artificial circulation. There are also several very good patented devices for bringing about this much desired circulation.

"Another item which might be classed as a boiler fitting is the so-called fusible plug which the law requires shall be fitted to the tops of combustion chambers and at other important parts of the boiler. This consists of a brass plug screwed into a tapped hole; the center of this plug is filled with a soft metal, such a Banca tin, which, when not covered by water, will melt and allow the steam to blow through the opening, thus acting as a safety vent."

CHAPTER VIII

Forced Draft

"Before leaving the subject of boilers, we will look into the matter of forced draft. Although this ship is not fitted with any system for that purpose, many other ships are, so it will be well for you to know about the various methods adopted.

"I have told you that air is just as important for combustion as coal itself. When fires are started in the furnaces the smoke and hot gases go up through the tubes and uptakes to the funnel or stack. You might wonder why they don't come back through the furnace and ash pit doors. The reason why they do not is due to what is known as draft, or the tendency to go up instead of down. Air when heated becomes less dense or lighter in weight, hence it is that at the furnace front and under the grate bars there is a tendency of the air to flow through and up. This tendency is due to the difference in weight of a column of cold air of the height equal to the distance between the level of the grates and the top of the stack, and the weight of a similar column of heated air of the same height. This difference in pressure or weight is usually very slight, but sufficient to cause enough air to flow into the furnaces to keep up a reasonable rate of combustion. In general, the higher the funnel the greater the difference in pressure, and consequently the better the draft.

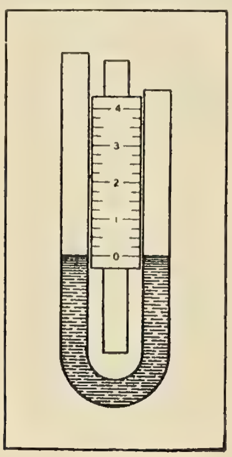


FIG. 5.—DRAFT GAGE

"Draft is usually measured by a device such as is shown in Fig. 5. One end of the U-shaped tube, which is located in the fire-room, is open to the air pressure in the fire-room, the other is connected by a rubber tube to the space under the grates. The difference between the two pressures compels the water to lower in the free end and rise in the end connected to the tube. We thus speak of draft as measured, not in pounds, but in inches or fractions of an inch of water. Were the pressure to be expressed in actual weight, such as a steam gage shows, you would find that 1 inch of water pressure would equal only two-thirds of an ounce.

"Ordinarily natural draft on a steamer of this size is about ¼ to ⅝ inch of water, and such a pressure under ordinary conditions is sufficient to burn enough coal to produce the desired speed of a vessel. There are times, however, when greater speed is demanded than can be produced by natural draft pressures. Fast passenger vessels, steam yachts and torpedo boats must go at full speed either all of the time or at intervals, and under these conditions a greater rate of combustion must be obtained. Hence it becomes necessary to use what is termed 'forced' draft, or in other words apparatus for furnishing a greater quantity of air to the furnace than would naturally flow in due to the difference in weight of the two columns of air.

"The most primitive system of forced draft is probably illustrated by the boy who, while shooting firecrackers, blows on a piece of punk in order to make the cracker fuses light easier."

"Chief," interrupted Schmidt, "I think we could have a good forced draft system on board this ship by making O'Rourke get on his hands and knees and blow under the grate bars; he's about as good a blower as I know of."

"That's all right," retorted O'Rourke, "about my forced draft; I know some one not very far off who couldn't be used for that purpose—he eats too much Limburger—his breath would put out almost any fire instead of making it burn faster."

"If you young men are running a debating club, we had better quit right here and let you fight it out," said McAndrew.

"Please go on with the forced draft, Chief," pleaded Pierce, who was by far the most earnest of the Floating School undergraduates.

"To return to the subject," continued the instructor, "forced draft on board steam vessels is produced by one of four general systems.

"The first and most generally used is the closed fire-room type, where all parts of the fire-room and boiler compartment are made as nearly air-tight as practicable, and the air is forced into the space by means of centrifugal blowers, which draw in the air from ventilators or sometimes from the engine room and discharge directly into the fire-room. As there is no other escape except through the grate bar spaces, the fires are forced by means of the greatly increased amount of oxygen available for the purposes of combustion. This system is more comfortable for the firemen, as the cooler air from outside makes the temperature lower. It gives, however, a somewhat uncomfortable feeling in your ears, as the pressure is, of course, greater than the ordinary pressure of the atmosphere."

"Why can't you put cotton in your ears?" inquired Nelson.

"You could if you wanted to, but the pressure would be on the cotton just the same, and there would still be a feeling of pressure on your ear drums.

"A steam jet in the funnel is another system of forced draft, and probably the simplest that can be devised. The most efficient jet seems to be one that is located right in the center of the stack, and so proportioned as to blow the steam out through a conical opening, causing it to spread out to the sides of the stack and creating a lowering of the pressure in the up-take, which causes a more rapid flow of the air through the fires. Steam jets are not very economical for marine purposes, as they waste too much valuable fresh water.

"On harbor boats or on vessels running in fresh water, they provide a simple and inexpensive forced draft. All steam locomotives use what practically amounts to steam jet forced draft, as you probably know that the exhaust steam from the two cylinders is turned into the stack, which with the engine at full speed produces a very strong draft.

"Ash pit draft is another of the four systems used. In this the air is led from blowers through sheet iron ducts, directly to the ash pits, where it is discharged underneath the grate bars. When it becomes necessary to charge the furnace with coal the draft must be shut off, else the flames and gases will be forced out of the furnace doors into the faces of the firemen. The best type of ash pit forced draft is where the air from the blowers is passed through a heater arranged in the up-takes, whereby some of the heat which would otherwise be lost in the escaping gases is utilized in warming the air which is used for combustion.

"Induced draft is used on many vessels; this is caused by locating a large blower at the base of the stack, which draws the gases from the up-takes and discharges them higher up in the stack or funnel. This is much less expensive than the closed fire-room system, and in case of any leaks in the breeching or up-takes the air from the outside rushes in, and thus prevents the escape of gases into the fire-room space, as frequently occurs when natural or forced draft of the other types is used.

"This will close my remarks on the subject of boilers, and as O'Rourke has fallen asleep twice in the last ten minutes. I think you had all better 'turn in.'"

CHAPTER IX

Engines

On the following evening McAndrew began his lecture by saying:

"Young men, we are now about to take up a subject which I know will interest you greatly, as you all hope to be engineers; that is, men capable of running and caring for engines.

"O'Rourke, what, in your opinion, is an engine?"

"Let me see," replied the spokesman of the class. "An engine is something that makes the wheels go around."

"You're right," replied McAndrew; "shorn of all qualifying verbiage that is really what it does, and that is its principal function. But how does it do it? that's the question. You all know that when everything is in readiness the man on watch opens the throttle and the screw begins to revolve. If that was the extent of your knowledge you would be simply engine starters and stoppers, but I trust you will know more about it before you get your licenses.

"As I told you before, if a cubic inch of water is turned into steam the latter would, under atmospheric pressure, expand into almost a cubic foot of steam. When, however, it is confined in a steam-tight vessel such as a boiler, it cannot expand into such a large volume, and consequently the pressure rises. When it reaches, say, a pressure of 180 pounds per square inch, it has a tendency to expand into the volume which it would occupy if all pressure were removed. It is this tendency to expand which makes steam valuable as a source of power, and the greater the pressure the greater the expansion. In this connection you should remember the fundamental rule that the pressure multiplied by the volume is always equal. Thus if we have one cubic foot of steam at a pressure of 100 pounds per square inch, it has the same expansive effect as would 10 cubic feet of steam at a pressure of 10 pounds per square inch.

"When steam is released from the boiler and enters an engine, it tends to expand like a compressed spring if the weight is taken from it. When it reaches the cylinder of an engine through the pipe connecting the boiler to the cylinder it starts to expand, and as the sides of the cylinder and the cylinder head are fixed and rigid, the only way it can increase in volume is to force the movable piston in the cylinder up or down as the case may be. This up and down motion of the piston is transmitted through the piston and connecting rods of the engine to the crankshaft which rotates and turns the propeller.

"There have been numerous kinds of engines invented to utilize the expansive force of steam, and step by step they have been improved upon, until now practically nine-tenths of all the marine engines in use are of the vertical, inverted, triple and quadruple expansion types and the more recent type known as the turbine. Obsolete types, or those which have outlived their usefulness, are of interest to show what steps have had to be taken to reach the present standards, but for your purposes the modern engines are those to which you should devote most of your attention.

"Nelson, what is your definition of a triple-expansion engine?"

"One that has three cylinders, sir," he promptly replied.

"That is true in part," said McAndrew, "as the majority of triple-expansion engines do have three cylinders; but I want to disabuse your mind of the idea, which so many youngsters seem to have, that the number of cylinders determines the type of the engine. Some compound engines have three cylinders, some triple-expansion engines have four and even five cylinders, so you see that your definition does not hold in all cases.

"Engines derive their classification or type from what we may call the different stages in which the expansive effect of the steam is utilized. A simple engine is one in which all of the expansive effect is utilized in one stage; a compound engine is one in which this is accomplished in two stages or periods; a triple expansion type is one in which it takes three stages of expansion to get all the work from the steam. Thus if we are using steam at 180 pounds gage pressure in the high-pressure cylinder (or first expansive stage) it partly expands during the first step to a pressure of, say, 60 pounds, when it is exhausted into the second stage, or the intermediate cylinder, as it is termed; there the expansive force is reduced to, say, 10 pounds gage pressure, when it again passes to another stage, or the low-pressure cylinder, in which it is expanded down to an absolute pressure of perhaps 2 pounds, depending upon the vacuum carried in the condenser. The whole process might be compared to wringing the water out of a tablecloth.

"Now, O'Rourke, I suppose when you were a boy you have helped your mother with the family wash on Mondays, haven't you?"

"Sure thing," he replied, "whenever I couldn't stick my kid brother on the job."

"Well, you might remember that your mother would take a tablecloth out of the bluing water and give it a twist, thus rinsing out considerable water; after a while she picked it up, took hold of one end of it while you took the other end, and you both twisted it as hard as you could, with the result that more water came out of it. Finally, she put it in the wringer, for which you probably furnished the motive power, and still more water ran out of it. Well, that's the idea of a triple-expansion engine; it takes three processes to get the work out of the steam, just as it took three processes for you to get the water out of that tablecloth."

"Gee!" said O'Rourke, "I must have been a triple-expansion laundryman and didn't know it!"

"I think from the sound of the hot air which escapes from him he must have been a simple one," volunteered his rival, Schmidt.

"Having, I hope, fixed in your mind the idea of a triple-expansion engine, we will now investigate some of its parts. The cylinders, naturally, are the most important of these, as in them the work of the steam is performed.

"I suppose you know that the name comes from the geometrical figure known as a cylinder, as the inside or working surface of the so-called cylinders is perfectly cylindrical; that is, it is exactly circular in section at any point. The outside of a marine engine cylinder is anything but cylindrical, owing to the valve chests, flanges, etc., necessary to fit it for its work.

"All steam engine cylinders are made of cast iron, because that is the ideal material for the purpose; no other material would fulfill all the requirements.

"The thickness of cylinders depends upon several things, the most important of which is the strain which it is required to withstand. However, you will find that they are always made much heavier than actually necessary, as all parts of machinery are, when designed, given what is termed a 'factor of safety.' That is, after you have calculated how thick any part should be from a theoretical standpoint, you make it actually three, four or even five times as thick, then you will be deadsure that you are on the safe side. You might think from that statement that designing engineers do not have much nerve, and as a matter of fact many of them are lacking in that essential. Experience has, however, taught them to be on the safe side, for in marine machinery particularly emergencies develop in the most unusual way at times which upset all theories. After cylinders have been in use for a number of years they may become badly scored or out of round, in either of which cases it is necessary to have them rebored. Consequently the designer must keep that contingency in mind when determining the thickness. You can always cut off portions of a casting, but you can rarely add anything to them, hence they should be heavy enough at the start.

"Attached to and cast with the cylinders are the valve chests which contain the valves for regulating the entrance and exit of the steam to and from the cylinders. They vary in size and shape in accordance with the type and sizes of valves used.

"The cylinder heads are, of course, a necessary adjunct to close up the tops of the cylinders. Relief valves are always fitted at the top and bottom of each cylinder to relieve any steam pressure in excess of the safe working pressure, but principally to relieve the cylinders of water pressure, in case, as may happen, water collects in the cylinders, either from being carried over from the boilers with the steam or from being condensed in the cylinders before they are properly warmed up. Water is, as you may have observed, practically non-compressible, so that if any collects either at the top or bottom of the cylinder, and the piston moves rapidly against it, something must give way. The relief valves, if properly adjusted, serve the purpose of allowing the water to escape and of preventing an accident to the head or to the cylinder itself."

(*To be continued.*)

United States Battleship Pennsylvania

Battleship No. 38, of the United States navy, to be named the *Pennsylvania,* was authorized by Act of Congress, approved Aug. 22, 1912, which stipulated:

"That for the purpose of further increasing the naval establishment of the United States, the President is hereby authorized to have constructed one first-class battleship, carrying as heavy armor and as powerful armament as any vessel of its class, to have the highest practicable speed and greatest desirable radius of action and to cost, exclusive of armor and armament, not to exceed $7,425,000 (£1,525,000)."

The usual plans and specifications of the vessel were prepared by the Navy Department. As is customary, and in order to carry out the provisions of the above Act, and to take advantage of all possible improvements existing in the construction of a ship such as contemplated by the Act, the Department, in advertising for bids for the construction of this vessel, invited proposals under two classes, viz.:

Class 1. For the construction of the hull and machinery on plans and specifications provided by the Secretary of the Navy; the installation of reciprocating engines and watertube boilers, fitted for burning fuel oil, being the principal features of construction with respect to the machinery.

Class 2. For the construction of the hull, for the equipment, the installation of ordnance and ordnance outfit and armor in accordance with plans and specifications furnished by the Secretary of the Navy, and for the construction and installation of the propelling machinery and its auxiliaries, the boilers to be fitted for burning fuel oil and the propelling machinery and auxiliaries to be in conformity with the *bidder's* design.

Specific guarantees of the total fuel-oil consumption per knot at contract speed and at speeds of 19, 15 and 10 knots were required.

Bids for the vessel were opened at the Navy Department, Washington, February 20, and the award of the contract for the construction of the vessel was given to the Newport News Shipbuilding and Dry Dock Company, Newport News, Va., on their proposal under *Class 2*, the contract price being $7,260,000 (£1,490,000), and the time of building 36 months. The main particulars of the hull are:

Contract speed	21 knots
Length between perpendiculars	608 feet
Breadth molded	97 feet
Draft	28 feet 10 inches

The distinguishing features of the design above the deck are the two military masts, one smoke-stack and fore-and-aft turrets, each equipped with three 14-inch guns. In the subdivisions below decks cofferdams surround all the fuel-oil tanks as a means of protection and safety.

Propelling Machinery

The propelling machinery will consist of an improved type of Curtis turbines placed in four watertight compartments, the turbines operating four shafts and propellers. The characterizing feature of the turbine installation proposed will be found in the arrangement of gearing in connection with cruising turbines to be used under cruising conditions. For purposes of disconnecting the cruising outfit, when running at higher speeds, a clutch is provided in the shafting between the main low-pressure turbine and the gear shaft.

In the arrangement of the turbines there are placed on the inboard shaft the main high-pressure turbine in the forward engine room and an independent backing turbine in the engine room located immediately aft of the forward one.

On the outboard shaft, in the forward engine room, is placed the reduction gear casing with the two cruising turbines, each of which connects with a pinion engaging with a large central gear. At 1,800 revolutions per minute of the cruising turbines the gear revolves 120 revolutions per minute. The main low-pressure turbine, with its ahead and astern elements, is placed in the after engine room, an extension of the rotor shaft connecting with the reduction gear.

When running at cruising speed, steam is admitted as follows: First to the high-pressure cruising turbine, then to the low-pressure cruising turbine with driving gear attached to the low-pressure turbine, then to the high-pressure main turbine driving the inboard shaft, and finally to the low-pressure main turbine driving the outboard shaft. All propellers turn outboard for ahead motion.

The usual auxiliaries consisting of condensers, main and auxiliary air pumps, feed tanks, main circulating pumps, feed heaters, etc., are located in the engine rooms. The vacuum to be maintained under full speed conditions is to be 1 pound below perfect vacuum of the prevailiing barometric pressure.

Forced lubrication, together with water circulation in the rotor journals and the horse-shoes of the thrust bearings, is provided.

Boilers

There will be installed twelve watertube boilers, in which the diameter of the tubes is not to exceed 2 inches. The boilers will be designed for burning fuel-oil by mechanical atomization in the burners. The burners will be of the Bureau of Steam Engineering type. The fuel oil system will consist of the necessary pipe systems, light and heavy service pumps, tanks, strainers and oil heaters. For control of operation there will be oil meters in the suction pipes, gears for operating fuel-oil valves and level indicators placed near the storage tank manifold. Hand pumps capable of delivering air to a few of the burners at 200-pound pressure, when the boilers are cold, form part of the equipment.

Air for combustion is furnished by forced draft blowers, the mixing of the air and the atomized oil taking place within the furnace of each boiler.

The steam pressure at boilers will be about 295 pounds gage, while at the turbines it will not exceed 265 pounds. The total shaft horsepower will be about 32,000 at 220 revolutions per minute.

The four-shaft turbine arrangement in the ship in question is a singular departure from prevailing customs with the Curtis turbine for marine use, where either two or three-shaft arrangements have been the rule. The former was used in the *North Dakota* and in all of the torpedo boat destroyers, the latter in such ships as the Argentine battleships *Rivadavia* and *Moreno* now building in this country.

A comparison between turbine and reciprocating engine installations for a ship like the one forming the subject of this article will show the diameter of the screws for the former to be 13 feet against 21 feet for the latter, the diameter of shafting 12.5 inches against 20.5 inches, the stress on the shafting 6,500 against 9,500 pounds per square inch of section, etc.

Considering the expected improvements in economic performance, both at full power and under cruising conditions (as due to better turbine arrangement, more efficient screws when the turbine power is divided among four screws as compared with two or three screws in former ships, and the geared cruising turbines), the growing tendency towards larger and speedier ships and the tactical advantages existing in the uniformity of ships, when in squadron, it seems quite in keeping with the progressive policies adopted by the navy to have accepted the contractor's proposition to install turbines in place of reciprocating engines for the propelling machinery of this latest, most modern and powerful dreadnought.

THE UNITED STATES BATTLESHIP PENNSYLVANIA AS SHE WILL APPEAR WHEN COMPLETED

(From *Scientific American*)

The Fuel Oil Situation

The action of the producers of fuel oil four months ago in practically withdrawing that product from the market is leading to the rapid development of substitutes with the necessary apparatus and methods. Until quite recently, after the extraction of the several grades of gasoline (petrol) and kerosene (paraffin) from the petroleum, the residue was considered as a by-product, valuable as fuel, also for the treatment of roads and some other purposes, and the cost to the consumer was low. The immense increase in the use of gasoline (petrol) has made it profitable to extract the residual naphtha from the fuel oil, and that fact accounts in part for the present attitude of the producers. Many plants are equipped to use oil as fuel in furnaces and forges, under boilers and for other purposes. Now the experts in the various substitutes are putting forth their best efforts in the attempt to give equally good results, and they are developing refinements which should be of great industrial value.

The heavier Mexican oil, of which the supply is enormous, is being used with some success in a modified type of apparatus, and promises to occupy a prominent place in the future. Common illuminating gas and producer gas are taking a more important place. That they contain sulphur has been, of course, an objection to their use in some metallurgical processes. But open-hearth furnace operations have long been based on gas producers, proper care being taken that the coal is low in sulphur, with all due precaution against "cold" gas and sluggish working of the furnace. In the various forms of heating furnaces and in the heat treatment of steel gas is used to an increasing extent. Welding has been done successfully, it is stated, using gas from a city main, containing the usual percentage of sulphur.

One theory of the present situation in fuel oil is that as soon as market conditions have driven large users to other fuels it will again be available to some of its present consumers in metal-working lines. The attempt now is, apparently, to reduce certain of the channels of consumption to the lowest possible point.—*The Iron Age.*

Engineers and Shipbuilders' Summer Meeting.—The Institution of Engineers and Shipbuilders in Scotland and the Institution of Naval Architects have arranged a joint summer meeting, which is to be held in the rooms of the Scottish Institution, Elmbank Crescent, Glasgow, on June 24, 25, 26 and 27.

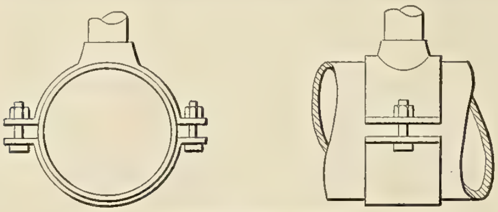
Letters from Practical Marine Engineers

Incidents Relating to the Design, Care and Handling of Marine Engines, Boilers and Auxiliaries; Breakdowns at Sea and Repairs

How a Little Difficulty Was Overcome

We had a 4-inch water service pipe that carried 30 pounds pressure, and it was necessary to lead a 1-inch pipe from same to an air compressor for cooling water, but the water service pipe had flanged joints and was too thin to tap for a pipe thread. Furthermore, there was nothing on board that could be used so that a valve could be installed. It was finally suggested that a fitting be made as shown in the sketch.

The blacksmith made a band in two halves, leaving a boss on one large enough to take the inch pipe. This was bolted together with distance pieces between lugs, and bored to fit the water service pipe, and the boss was drilled and tapped. Then it was fastened on the 4-inch pipe with a red lead joint, and the tapping drill put through the pipe and the hole tapped. The nipple was made long enough to screw through the boss and pipe.



A NOVEL PIPE FITTING

This made a very strong job, and answered its purpose so well that it has never leaked a drop since it was put up, and that was over five years ago. From appearances I should say that it will outlast the pipe. I have seen many pipes strapped to stop leaks and to strengthen weak ones, but I have never before seen a new lead taken from a pipe in this way. As it was new and a handy contrivance to me I felt that it might help others. READER.

Breaking Gage Glasses

A few years ago I was an assistant engineer in a vessel plying between the States and small Mexican seaports. One trip, after spending some little time in a shipyard, we put out to sea, but were continually annoyed by having the main boiler gage glasses break. A glass would last about three or four hours, often less. Not carrying a large supply in our stores, we soon found ourselves with about four left, and having at least two weeks ahead of us before we could renew our supply, we began to look for the cause, as the same brand of glass had given satisfactory service before.

The fitters in the shipyard had put up a new water column on the starboard boiler, which was the boiler that was giving all the trouble. On examining its water glass connections, we found the top one quite out of line with the bottom one.

At the risk of breaking it off, we used a large Stillson wrench and managed to turn it, thus bringing both connections in line. But, being shy of main boiler gage glasses, and having a good supply of donkey boiler glasses, the chief engineer devised a plan to use the smaller glasses till we got home. Having some brass pipe on board, the outside diameter of which was the same as that of the main boiler gage glasses, we cut lengths of this pipe which, in addition to the short donkey boiler glasses, would equal the required length of a main boiler glass.

We cut threads on one end of these pieces of pipe and screwed on part of a union with the nut. Our donkey boiler glasses just fitted inside the union nut, for which we cut several washers from ¼-inch canvas insertion packing. The lower nut being too large for the donkey boiler glass, we cut washers for each out of ⅛-inch sheet brass, whose outside diameter fitted inside of the nut and whose inside diameter just fitted the donkey boiler gage glass. We put the device in place, setting up the top nut with usual washers on the brass extension piece and then fitting the gage glass in place, setting up the nuts in the usual manner.

This device worked without mishap. I do not think we even renewed the original glasses on the voyage home. As the glasses were small, we were very careful to see that they did not choke and thereby risk dropping or heating our combustion chamber top. P. R. S.

Some Repairs to a Side Wheel Steamer

When the *P. S*—— was docked for her annual overhaul it was discovered that one of the paddle shafts had developed a crack in the wing journal as shown at *A* in Fig. 1. This is no unusual occurrence in side-wheel steamers and seems to be due to the overhang of the paddle wheel.

It was decided to remove the faulty shaft and replace it by another. With this object in view we proceeded to remove the crank web, as this was to be used in the new shaft. The usual method is to up-end the shaft with the crank end on the ground, build a mold round the crank boss and run in molten cast iron so as to expand the eye. If the crank is now tapped with a heavy hammer it will come off, but this case proved the exception to the rule. In spite of repeated heatings and hammerings, assisted by much profanity, the crank refused to budge.

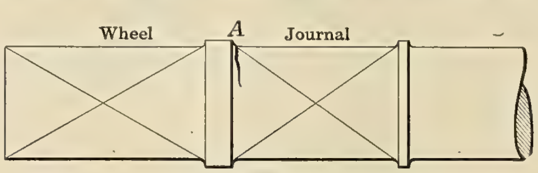


FIG. 1

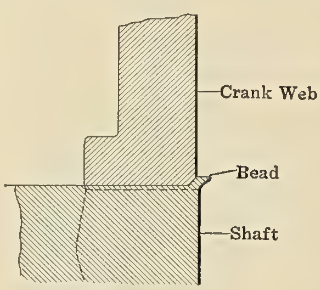


FIG. 2

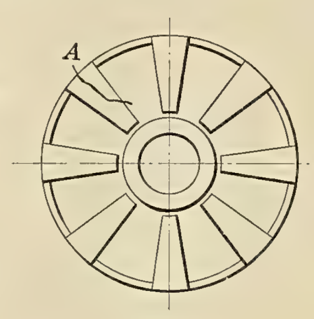


FIG. 3

This continued throughout an afternoon, at the conclusion of which an inspection was made, when it was discovered that the shaft was *riveted over* and finished off with a neat little bead in the manner shown in Fig. 2. This is a most unusual method of fixing a crank web to a shaft, and the only theory to account for it is that it was originally done to hide a bad shrink.

The crank was eventually removed by boring out the shaft as shown by the dotted lines in Fig. 2 and machining away the bead and countersink. At this juncture an apprentice discovered that the paddle center was cracked as shown at *A* in Fig. 3. The crack seemed to have been caused by the hammering in of the paddle arms. The superintendent said that we had caused it, and, as it had been decided to fit a new center, to set all doubts at rest the center was broken by being struck near the crack with a "dolly." It was found that the crack had been there months, if not years.

The owners were in a hurry to get the steamer on her run, so the new center had to be made as quickly as possible. The making of the pattern occupied three days and nights almost to a minute. The center was cast and machined and the arms fitted complete in twelve days and nights more, making the total time on the job of a fortnight and a day, which is, I think, a record for this side of the "herring pond." It would be interesting if any reader could bring forward an account of a similar performance.

Scotland. "Ison."

More Comment on the Possibilities of the Oil Engine

Kindly allow me a little space in your publication to comment on the article by Mr. J. F. Wentworth, dealing with the "Possibilities of the Marine Oil Engine," which appeared in the March number.

Mr. Wentworth mentions a new method, devised by himself, to obtain the necessary temperature to ignite the fuel oil in a Diesel engine by preheating the air and thus obtaining the required temperature at a lower pressure, say 250 pounds per square inch, instead of 500 pounds. As a matter of fact, this method is not new. It has already been used by several builders in Europe, such as Ing. P. Kind & Company, of Turin; Gasmotoren-Fabrik, Deutz and Aktiebolaget Diesels Motorer, Stockholm, and is called a semi-Diesel cycle, in which the air is preheated for exactly the same reason as Mr. Wentworth exposes. The only difference is in the method of preheating. In the Wentworth method air is preheated by external means. I do not know the nature, but it is evident that another source of heat must be provided, as Mr. Wentworth makes manifest a personal grudge against the hot bulb.

In the semi-Diesel engines above mentioned the air is preheated by the air of a hot bulb. It is evident, then, that the hot bulb's function is to raise the temperature of the air and not to iginite the fuel, as in the low-pressure bulb engines in which the fuel is sprayed against the hot bulb itself or an appendage therefrom. Soot is a deposit of burned, or partially burned, particles of oil in which there are particles of liquid oil or moisture. Soot, as Mr. Wentworth tries to make us believe, does not deposit against the hot bulb, as its temperature would prevent it from remaining soot. What deposits against the hot bulb is only a layer of baked particles of fuel or residual carbon, the presence of which would not hinder combustion very much. As a matter of fact, a well-designed hot bulb is fouled very little, and in a semi-Diesel engine it should keep at a white heat surface continuously.

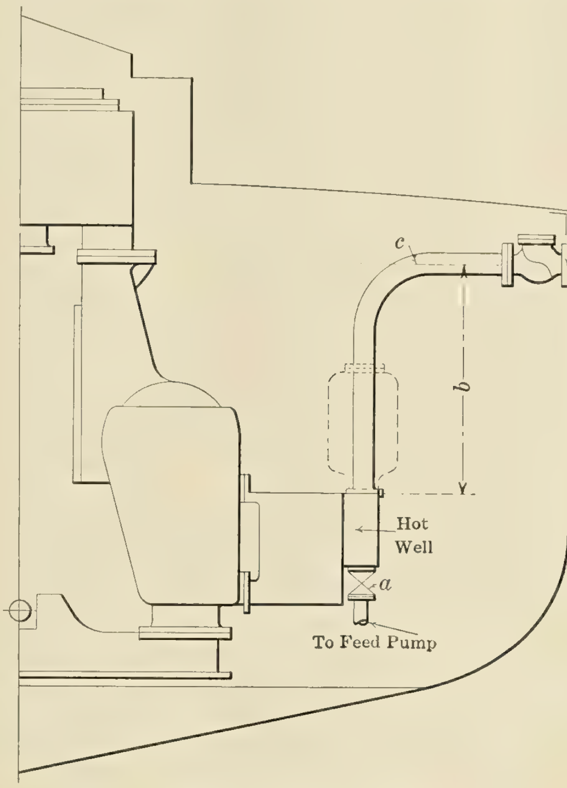
Hence both methods will give the same results as far as raising the temperature of the air is concerned. The real merit of any one method lies in its thermal efficiency. It seems to the writer that an outside source of heat entails an additional supply of heat units, and consequently losses in an apparatus that certainly cannot be 100 percent efficient. The heat supply should be added to the heat supplied by the fuel in the engine itself, and the heat utilized and transformed into energy should be, in percentage of the heat supplied, the theoretical thermal efficiency of the system. The hot-bulb method does not require an outside source of heat, as it is only heated once, and the heat is maintained by the fuel combustion, hence the thermal efficiency of the latter system should be higher.

The writer invites from Mr. Wentworth a thermo-dynamical analysis of both methods to show whether his (the Wentworth method) is the more efficient one or not.

Quincy, Mass. J. Barraja-Frauenfelder, M. E.

Difficulties with a Waste Pipe

The water from the air pump of surface condensing engines is mostly led to an oil filter, from which it is drawn away by the feed pump; and in small engines directly to the feed pump. A pipe from the top of the air pump connects the hot well to the vessel's skin, and through this pipe the air from the condenser will escape. On the skin in this connection is fitted a non-return valve, preventing in a seaway the sea



ARRANGEMENT OF WASTE PIPE

water from entering the pipe, so that it is impossible for salt water to mix with the feed water. For small engines this valve is nearly always a common steam valve.

On the small tug *E*—— such a valve was fitted. When the engine made her first revolution at the works all was well, but the water from the condenser was all pumped overboard, the feed pumps drawing the feed water from the river. This was always done with new engines, as with those very much oil and grease is used, so that a large quantity of oil would be pumped into the boiler. But afterwards it was preferred to use the water from the condenser for feeding the boiler, the cock, *a*, at the bottom of the hot well was turned on. But now it was seen that the feed pump could only pump a small part of the water to the boiler, as the greatest part was discharged with the air overboard. The cause of this was soon understood.

In the sketch the air pump, etc., are shown. The distance, *b*, from the top of the hot well to the pipe was only 2 feet. With up-going pump bucket the air was discharged through pipe, *c*, overboard and at the end of the upstroke a partial vacuum was formed in this pipe by the rush of the air as the non-return valve closed after the air column had been set to rest. By this partial vacuum the water in the hot well would rise into the pipe, *c*, and with the following upstroke of the air pump bucket it was discharged overboard. As such small engines with a larger hot well and longer waste pipes had never given any trouble, it was thought desirable to enlarge the space between the top valves and the discharge valve. This was done by fitting a large air vessel as indicated in dotted lines. It was thought that the partial vacuum would be much less, so that the water could not rise into the pipe. In fact, after the fitting of this air vessel, no further trouble was experienced. D. K.

Loose Dowel Pin in Crank Shaft

During my career as a marine engineer, many and varied were the accidents and breakdowns that occurred to the main engines and boilers. One I remember above others, as, had the defect not been discovered and remedied when it was, a total breakdown would have been imminent. I refer to the dowel pin in the afterside of the low-pressure crank pin becoming slack and gradually working out.

For the benefit of those readers who do not quite grasp what a dowel pin is, I will briefly explain:

First the crank pin is shrunk into the web, which is usually bored out one sixty-fourth smaller than the pin, then heated until it expands large enough to allow the pin to enter into its correct position, and cooled down. After this a hole is drilled midway between the web and the crank pin and to a depth of about two-thirds the thickness of the web. Then a pin is made to drive into this hole, making a good tight fit (for a crank pin of 16 inches diameter, the hole is 1 inch diameter). This pin is known as a dowel pin.

On this occasion the fourth assistant engineer was relieving me, and as usual went the rounds of the engine and boiler rooms, to satisfy himself that everything was in order before taking over the watch. When he arrived at the after side of the low-pressure main bearing No. 6, he let out a big war whoop. The dowel pin had come out some way beyond the surface of the web, and in feeling the main bearing the crank came round and the pin caught his hand on the back and laid it open, necessitating his laying up for the remainder of the voyage of four weeks.

The engines were *immediately* stopped, the turning engine placed in gear, and the crank brought to the top center. We found the dowel pin had slacked out 3/8 inch. Had it come out much more the damage would have been serious, as there was very little clearance between the engine framing and the crank web.

We drew the pin, which seemed to be very slightly tapered, and found the crank pin itself loose in the web. The space between the web and crank was thoroughly cleaned out by squirting in kerosene (paraffin) oil, and small strips of thin tin were forced into the space all around the crank pin. These strips were about 1/8 inch broad by 5 to 6 inches long. We redrilled the hole, making it slightly larger, and made a new dowel pin on a small lathe we fortunately possessed in the tunnel, and drove this pin down good and tight with a "dolly."

To insure doubly against further delay and accident, we drilled another hole the size of the original dowel pin in the forward side of the same crank pin and web in a similar position, and drove another pin, which made a good solid sound crank pin once more.

The breakdown occupied considerably the best part of all night, as drills had to be made and the drilling done by ratchet, but the ship was not delayed very much. The vessel was a twin screw steamer and, as is usual on such occasions, we forced the good engine and made up partly for the disablement of the other one.

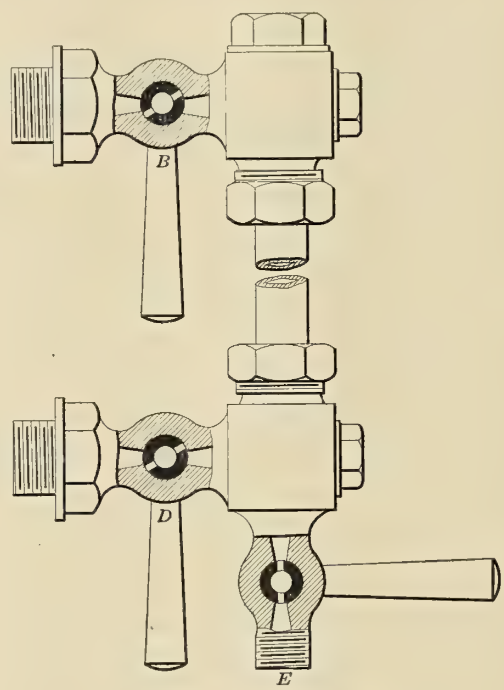
Several theories were advanced as to the reason of the above accident. My own opinion is that the thrust bearing was slack in its seating. We found this to be the case later, and consequently the longitudinal stress was taken by the crank shaft and tended to throw a greater stress on the working parts, particularly the big or bottom ends of the connecting rods, and also the main bearings; thus the crank was forced forward and the engines were thrown out of line, and when reversing took place the throw was in the opposite direction. The constant backward and forward stresses on the web loosened the crank pin and resulted in the above trouble.

Woodbridge, N. J. F. C.

Water Gage Fittings

The above in a steamer's engine room are possibly the most important fitting carried. Almost all seagoing engineers have had minor troubles concerning them, and neglect of their general well being brings sure trouble in a very short space of time.

Where the gage glass is mounted on a column with connecting piping to the lower part of the boiler and to the steam space respectively, care is necessary to insure that the water end of the piping does not become furred up. Instances have come under my observation where the cross sectional area of



GAGE GLASS ATTACHMENTS

actual water passage has been reduced to 1/4-inch diameter and even less by furring up. The water in the lower limb is quiescent and at rest—ideal conditions for the formation of soft scale.

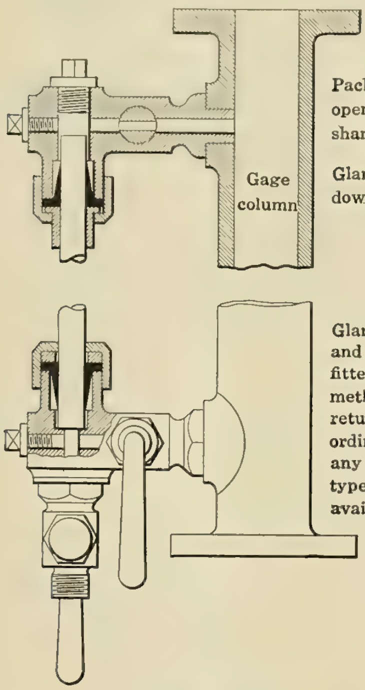
It cannot be too strongly insisted upon that this lower range of piping should come down every six months for thorough cleaning. Sometimes these pipes are fitted with oval flanges not stiff enough for an effective joint. Oval flanges from bitter experiences should, in my opinion, be barred for high-pressure steam, always forming an everlasting sore place in the engine room.

Engineer candidates for British Board of Trade certificates get severely handled over the question of blowing through the water gage, and in the examination room is provided a full size set on which every candidate, without exception, has to perform.

A misleading water gage is worse than useless, and casualties have happened owing to the handles of the cocks having been twisted relative to the openings through the gage. The sketch shows this by no means unusual defect.

A possibility to be borne in mind by all engineers is the blanking off of the steam space by the use of too long a glass, and so leading to a false level. Of course all the old hands are aware of this possibility, but it is worth notice in passing.

I do not know if the type of packing similar to a hydraulic leather is as well known as it deserves to be in America. Those sold here are of a patented composition similar to hard rubber in appearance. Gage glass mountings fitted for ordinary packing can be easily modified to suit this type of packing by the alterations shown in the sketch. The advantages of this type of packing are manifest. No spanner for nuts is needed, nor a box of assorted odds and ends, nor is any time lost in changing a broken glass. I have had a gage



GAGE GLASS PACKING

glass last, under my charge, twelve months, by reversing same, steam end for water. A curious phenomenon is that the steam end of the glass gets corroded and pitted in a remarkable manner. I attribute this to the use of soda in the boilers, to the possibility of weak acid solutions being present, and to the possible unstable composition of the glass under high temperature and pressure. With the older type of packing this curious happening is never seen, as the glasses never last a sufficient time.

An important advantage with these rings is that packing material simply cannot be forced over the orifice of glass, and so lead to "false water."

The British Admiralty have adopted a packing consisting of a stout tube of asbestos encasing a rubber ring in the interior, the asbestos being in two halves and the whole well black leaded. In this wise the resiliency of the rubber is preserved over a long period.

Actual gage glasses should be ordered to the dead length required with fused ends, not cut to length. Incipient cracks are present when the glass is cut to length, no matter how carefully, let alone when the time-honored round file is used. The glasses should be carefully annealed by the makers, the best of whom will furnish a guarantee that this has been done and that each separate glass has been individually tested to 1,000 pounds per square inch. In storing them care should be taken that they are not liable to be scratched. A wooden box should be kept and each glass should have an indiarubber ring slipped over to keep them from rubbing against each other.

The writer, who has had the inspection of many new boilers under his care, considers that sufficient trouble is not used by makers to insure linability of the gage glass mountings. A ground steel bar the full length of the gage and fitting both glass spaces is used by him to test this very important matter.

Gage glasses under steam should be protected from cold drafts of air. The necessity of this is apparent from the ordinary domestic lamp chimney.

One instance of the trouble which can happen at sea from repeated breakages occurred in a freight steamer on a twelve-day passage. Starting with over a dozen spare glasses on board, after seven days every glass had been used up, and a passing vessel had to be signaled and asked as a matter of courtesy for the gift of half a dozen. The engineers on her could get no sleep. It took one all the time to attend the boiler test cocks, and as usual the engineers per square foot of fire grate were not sufficient for the extra duty. The writer was a member of the crew of the signaled vessel.

The following, on a little understood but well-known phenomenon in connection with water gages, is due to the late chief examiner of engineers to the Board of Trade:

"When a water gage, clear in all its parts, has been blown through, the water in the glass rises above the level at which it formerly stood, immediately drain cock is closed. If left undisturbed for a time it gradually falls to its former position.

"The amount of rise depends chiefly on the temperature of the boiler and on the length of the pipes connecting the gage to the boiler. It frequently amounts to 4 inches, and the time needed to resume former level is from 30 to 40 minutes.

"The cause is twofold: (a) The displacement of the comparatively cold water in the water pipe to gage by hotter and proportionately lighter water from the boiler; (b) a slight condensation of the steam and corresponding fractional reduction of pressure in the steam pipe to the gage.

"The resumption of former level is caused by the converse of these actions added to the amount of air released from the steam condensed in the steam pipe to the gage, this lessening condensation.

"Another factor modifying the above causes is that if the water in the boiler be dense, the condensation of the steam in the gage causes the water in the lower part to be fresher and therefore lighter than that of the boiler."

London. A. L. Haas.

Making Your Own Graphite Paint

For making 10 gallons of good graphite paint, use 20 pounds of finely powdered or defloculated graphite, the balance to be made up of a good boiled linseed oil. Mix these thoroughly and then from thirty-six to forty-eight hours will be required for thoroughly drying. A small amount of drier can be used if it is preferred to dry the paint more quickly. The proportion of drier should be ½ pint to 5 gallons.

The writer has found from experience that the manufactured graphite is better for paint making than the mined variety, though some of the mined amorphous graphite will answer very well for this purpose. A graphite for paint making should run at least 90 percent graphitic carbon for the best results.

A good ready mixed graphite paint costs from $1.50 (6s. 3d.) per gallon up. By following the above receipt, a paint equal to any of the higher priced paints on the market can be obtained at about one-third the cost.

A Brother Engineer.

Marine Articles in the Engineering Press

Locating Friction in our Transportation Systems.—By R. H. Rogers. The chief cause of friction in transportation facilities is held to be the increased terminal charges. Two things are contributing to the rising terminal cost, which are congestion and a higher wage scale. The author points out how the expense of handling freight at terminals compares with the hauling of the same freight on a sea voyage or railroad journey. The use of electrical machinery is suggested as the most profitable application to the problem of reducing the cost of freight handling at steamship terminals. 3 illustrations. 1,400 words.—*General Electric Review*, March.

New Dry Dock at Manitowoc.—A new sectional steel floating drydock, which has a lifting capacity of 6,000 tons, has recently been built by the Manitowoc Shipbuilding & Drydock Company, Manitowoc, Wis., and established in Manitowoc harbor. The dock has an over-all length of 480 feet and a width of 70 feet between the wings on the keel blocks. The dock is composed of five independent sections, held together by a belt of 1¼-inch bolts, spaced 6 inches center to center, extending clear around the inside of the dock. The complete dimensions of the wings and pontoons, together with the general features of the framing and plating, are given in the article. Each section is equipped with an electric-driven turbine pump manufactured by the Rees Roturbo Manufacturing Company, Ltd., which has a rated capacity on a 20-foot head of 3,060 gallons per minute. The pump requires 25 brake horsepower to operate it, and as each section has its own pump the entire dock can be pumped out in about two hours. 5 illustrations. 1,300 words.—*The Marine Review*, March.

A Geared Turbine Cargo Steamer.—The steamship *Cairnross*, a ship 383 feet long, 51 feet beam and 7,850 tons deadweight capacity, with a speed of about 10 knots loaded, built by William Doxford & Sons, Ltd., of Sunderland, is a sister-ship of the *Cairngowan*, both of the vessels being owned by the Cairn Line of Steamships, Ltd. The former, however, is driven by two Parsons steam turbines geared to a single propeller shaft, while the latter is a single-screw steamer with the ordinary type of triple expansion engines. In the turbine-driven ship, the high-pressure and low-pressure turbines have each its own pinion on one side of the gear wheel, which is coupled to the propeller shaft, the whole of the gearing being inclosed in a cast iron casing. Eight large jets of oil are played on each of these pinions. There is no floating platform in connection with the gear, the thrust being allowed for by jaw clutches between the turbines and the gears, and these clutches have a certain amount of end play. The engine rooms of the two ships are of the same length, but the machinery of the turbine-driven ship is 20 tons lighter and, as this form of propulsion has shown better fuel economy, the turbine-driven ship is able to carry an appreciable amount more cargo on the same displacement. 5 illustrations. 1,900 words.—*The Engineer*, March 7.

A Comparative Survey of Battleship Design.—The 13.5 and 14-inch gun ships. This article is a continuation of an article published under the same title which was reviewed in our January issue. It discusses only those ships carrying 13.5 and 14-inch guns, of which some forty-two are built, building or projected. The various ships of this class belonging to the different nations are described and compared as regards their offensive and defensive powers. Various designs are criticised to show what the author considers as the chief defects of the different ships and how they might be improved, as, for instance, in the *King George V* class, the chief defect is pointed out as the inadequate secondary battery, which in this case consists of only 4-inch guns. The weak point in the designs of the United States battleships *Texas* and *New York* the author considers to lie in the method of armor distribution, although this fault is common to their contemporaries. One point in particular is noticeable in the types dealt with, and that is the universal acceptance of the center line and raised turret arrangement. No tendency is evinced to increase the caliber of the secondary guns beyond 6 inches, nor to mount an excessive number of torpedo tubes, except in Germany. The speed remains in the region of 20 to 22 knots, and the internal combustion engine for propulsion has not yet materialized in the battleship. Big guns show signs of reaching a maximum caliber within the next few years, and the 1,000-foot ship is coming into practical perspective. All this points to the completion of the steam-driven ship era within the next decade and the commencing of a new cycle of motor warships, probably starting at small dimensions. 5 illustrations. 2,700 words.—*The Shipbuilder*, March.

The Quadruple Screw Steamer Reina Victoria Eugenia.—The *Reina Victoria Eugenia* has been built by Messrs. Swan, Hunter & Wigham Richardson, Ltd., at their Neptune Works, Newcastle-on-Tyne, to the order of the Compañhia Transatlantica of Spain, and is intended for service between Italian and Spanish ports and the River Plate with mails, passengers and emigrants. The vessel is 500 feet long over all; 480 feet long between perpendiculars; 61 feet molded breadth; 61 feet 3 inches extreme breadth; 35 feet 9 inches molded depth to upper deck; 10,000 tons gross tonnage; 18½ knots speed; total capacity for passengers and crew, 2,387. The vessel is built of steel, the scantlings and construction being in accordance with the requirements of Lloyds register for their 100 A-1 shade-deck class. A cellular double bottom, 4 feet deep, extends the full length of the vessel between the peak bulkheads. The double bottom is divided into eight transverse compartments, five of which are further subdivided by a central watertight division, providing ample space for water ballast. The watertight subdivision of the ship is further accomplished in a very complete manner by nine transverse watertight bulkheads, which extend to the upper deck. The compartments beneath the lower deck are devoted to cargo, bunker and machinery spaces. Forward there are two cargo holds and aft two more. Between the cargo holds, commencing from forward, are a reserve cross-bunker, a second cross-bunker with a recess for one boiler, the boiler rooms, then another cross-bunker, aft of which is the engine room, and then the dynamo room and thrust recess. The passenger accommodations and appointments of the vessel are described in detail. The vessel is propelled by four screws, which are driven by reciprocating engines and turbines arranged on the combination system. Each of the two inner propellers is driven by a set of four-crank, triple-expansion reciprocating engines, with cylinders 29 inches, 43 inches, 47 inches and 47 inches diameter by 42 inches stroke, while each of the outer screws is driven by a low-pressure turbine of the Parsons type. Steam is supplied by seven single-ended boilers, working under Howden's system of forced draft. 3 illustrations. 2,200 words.—*The Shipbuilder*, March.

Liquid Fuel as a Source of Energy for the Propulsion of Ships.—By C. Zulver. For a number of voyages of the same ship, with boilers burning either coal or oil, and the engines kept running as nearly as possible in the same condition as regards vacuum, revolutions, etc., it has been found that in a ship with a deadweight-carrying capacity of 7,700 tons there is a mean saving by weight in fuel consumption of 33 percent when oil is used as fuel instead of coal. As a direct consequence it was found that the ship carried about 150 to 200 tons more cargo, and also an appreciably better speed has been maintained by the oil-fired steamer. In connection with the Diesel engine the author points out that the fuel consumption of the *Vulcanus* has not exceeded 2 tons of solar oil per day, which is only about one-fifth of the coal consumption of a steamer of like capacity, while the cargo-carrying capacity of the *Vulcanus* is from 12 to 15 percent more. Particulars are given as to the performances of the motor vessels *Vulcanus* and *Juno*, and complete details are also given of the various oil-burning systems. The author asserts that oil fuel can be used with practically any type of steam boiler, the methods chiefly in favor being mixing the oil with a steam jet and heating and atomizing it by means of a steam burner, or using compressed air burners or the direct pressure systems. In discussing the oil engine, the author favors the four-cycle engine as compared with a two-cycle marine engine. The features which in his opinion are drawbacks in the two-cycle engine are: (1) Double heat generation of pistons; (2) ports in the bottom of the cylinders, making a permanent tightness of a liner doubtful; (3) complications with scavenging pump; (4) higher fuel consumption; (5) no relief to moving parts, thus necessitating larger bearing surface; (6) long trunk piston necessary to close ports in the bottom of cylinder. Illustrated. 8,000 words.—*Institute of Marine Engineers,* February.

The Electric Propulsion of Ships.—In an editorial discussion of the application of electricity to the propulsion of ships, it is pointed out that electric transmission is by no means a new departure, and it is suggested that the main reason why this form of propulsion has not been adopted on a large scale is not that the claims put forward by the advocates of electric propulsion are in any way impossible, but that simply from the small amount of practical evidence available from actual installations it is unlikely that the majority of shipowners would be prepared to give much attention to the proposals. The need of practical evidence from installations carried out on a large scale is strongly emphasized. The two large installations now under way—namely, the United States collier *Jupiter* and the Diesel electric ship being built by Messrs. Swan, Hunter & Wigham Richardson—are pointed out as likely to do much towards building up such evidence, although these two cases cannot, of course, prove the case for any general adoption of marine electric transmission. Electric transmission seems to have greater advantages for warship propulsion than for use in merchant vessels, since in warships a greater variation in speed is necessary with economical operation of the propelling machinery at both low and high speeds. Such a matter is of little interest in connection with either passenger or tramp ships which operate almost wholly at full speed. 1,400 words.—*Engineering,* Jan. 17.

Recent Experiences with Babcock & Wilcox Boilers.—By W. J. H. Rosenthal. Since the trials made by the Admiralty Special Boiler Committee of 1900, the Babcock & Wilcox boiler has been very extensively adopted for large naval vessels. In the mercantile marine up to June, 1912, 542 Babcock & Wilcox boilers had been fitted in 253 ships, the total horsepower being 411,479. Installations had shown that the essentials for the successful use of watertube boilers were: (1) Well constructed and tight condensers; (2) the use of as little oil as possible in the engine cylinders and proper means of filtering the feed water; (3) evaporators of adequate size; (4) regular examination of the water in the boilers, and (5) a careful and interested engineer. The conditions are regularly attained at the present time in all well-engineered vessels. A comparison of the cross-channel steamers *Victoria* fitted with cylindrical boilers, and *Engadine* fitted with Babcock & Wilcox boilers, showed that on seventy-nine and ninety-four double trips, respectively, the *Victoria* attained an average speed of 21.272 knots and the coal used was 24.59 tons per trip, while on the *Engadine* the figures were 22.367 knots and 24.77 tons. It has also been found that on the Stranraer and Larne service there is economy in fuel in favor of the *Princess Victoria* over the *Princess Maud,* a sister-ship of the same power, but fitted with cylindrical boilers. In the case of three sister-ships of 8,000 tons displacement, engaged on the passenger service between New York and New Orleans, the average consumption for a series of voyages was as follows: Steamship *Creole* fitted with Babcock & Wilcox boilers, 1,149 tons; steamship *Momus,* with cylindrical boilers, 1,412 tons; steamship *Antilles,* with cylindrical boilers, 1,336 tons. In an intermediate passenger steamer of 5,000 horsepower it has been estimated that by fitting Babcock & Wilcox boilers there would be an increase of heating surface of 23 percent, an increase of grate surface of 34.3 percent, a saving in weight of 225 tons, a saving in floor space of 14.33 percent, and a saving in fore-and-aft length of 12 feet. Furthermore, steam can be raised more quickly; devastating explosions and the risk of detrimental strains due to forcing would be avoided, and the boiler would be more suitable for higher pressures.—*The Institute of Marine Engineers,* March.

The Oddie Simplex Feed Pumps and Air Pumps.—A detailed description is given of pumps fitted with Oddie's patent simplex valve gear, a gear which has come into use largely in late years in connection with marine work. The action of the Oddie simplex pump is in reality based on the same principles as that of the duplex pump, for the single valve of the Oddie pump, it is claimed, takes the place of the second piston of the duplex pump, with the important difference that with the Oddie pump the reversing of the piston can only take place after the stroke has been completely finished. Another advantage is that the gear positively controls the working of the steam by mechanical means throughout the whole length of the stroke. The control of the piston is so regulated during the stroke that a motion very like that of a crank-moved piston is obtained. This is quite independent of the reversing movement at the end of the stroke, and is peculiar to the Oddie pump. It is, moreover, the cause of the working of the pump being very quiet and smooth even at the highest speeds. Two types of pumps are described, the feed pump and the air pump. The mechanical distribution of steam by the action of the single valve, which combines the functions of an auxiliary distributing expansion and reversing valve, is peculiar to the Oddie system and forms the characteristic difference between this system and others. It possesses the important advantage that the piston motion starts slowly and without shock, is accelerated to the middle of the stroke and then gradually slows down towards the end of the stroke. In the description of the Oddie air pump the difficulties encountered with the application of the commonly used three-valve type of pump when coupled to a single steam cylinder, are pointed out, and it is claimed that the Oddie air pump surmounts these difficulties entirely. In the Oddie air pump air and water are not only drawn in on the upstroke, but are also drawn in for a large portion of the down stroke. In the Oddie pump the displacement per double stroke is far higher than in a pump of the ordinary three-valve type. Further, in the Oddie pump the work is better divided between upward and downward strokes and the pump can, therefore, be run quicker and quieter than a pump of the three-valve type. The Oddie pumps are manufactured by the Machinenfabrik Odesse G. m. b. H., Oshersleben, Germany. 19 illustrations. 1,900 words.—*Engineering,* Jan. 31.

New Books for the Marine Engineer's Library

A New Book on Steam Turbines

REVIEWED BY PROFESSOR C. H. PEABODY*

Design and Construction of Steam Turbines. By Harold Medway Martin, Whitworth Scholar. Size, 7½ by 10¾ inches. Pages, 372. Illustrations, 523. London and New York, 1913: Longmans, Green & Company. Price, 25s. net.

It may not be faimiliar to all our readers that the celebrated engineer Whitworth left a fund for the liberal education of a few selected men of exceptional ability, and that custom, which is stronger than law, has required that, whatever other training these young engineers might have, they must become proficient in mathematics. The selection and training of these men are greatly valued by themselves and by the public, so that there is no prouder title than Whitworth Scholar, and the work done by Whitworth Scholars has abundantly justified the establishment of the fund; this book is a worthy example of their accomplishments.

The book is written as a manual for engineers and is neither intended nor adapted for students in technical schools, or perhaps it may be said that such students may read it to best advantage after a good course of instruction in steam engineering and steam turbines.

The book is divided into several parts, as follows: (1) A statement of rules and formulæ, without proof, including the use of the Mollier diagram; (2) a general method for the preliminary design of any steam turbine; (3) designs of various types of turbines, such as impulse turbines, velocity compound turbines, reaction turbines, and radial flow turbines; (4) a brief discussion of thermodynamic principles; (5) such features of the design and construction of turbines as balancing, labyrinth packings, high-speed bearings, gearing and condensers; (6) detailed description of various types of turbines with dimensioned drawings.

The relative values of the different parts of this manual may be considered to be in general in the order of the divisions. The first part of the book presents just those features that the trained designer (who has learned, digested and passed into his subconsciousness the theory of turbines) must have at hand, presented by a master of the subject with the mathematical ability to deal with abstruse theories, and the wisdom to abstain from prolixity. Here one finds those methods and details that have been developed by turbine builders and at their proper discretion withheld from general dissemination.

The author's method of provisional design is most happy, as it allows the designer to determine quickly the general proportions and dimensions of his design and its efficiency, and thus avoid a repetition of the elaborate computations for a complete design that might be required if undertaken without knowing whether the design when completed would conform to practical limitations.

The Parsons type of turbine, predominant in England, naturally receives most extensive treatment, and this is most welcome to American engineers, who in general have less information concerning this type. Since the customary construction places blades in groups, special importance is given (in two complete chapters) to the flow of steam through groups of blades, both theoretically and practically.

Radial flow turbines involve the combination of thermodynamic and centrifugal actions on the steam, and in general receive scant attention from writers, and consequently the author's chapter on that type and the application to the Ljungström turbine is most welcome

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The thermodynamic treatment of the author is perhaps sufficient for a book of this character, but the reviewer cannot agree that there is any necessity for the approximate computation of velocity by the aid of exponential equations, even though the author controls his exponents so that his approximations are sufficient. So long as blades are arranged in groups which commonly have both equal length and constant angles, computations by ordinary thermodynamic methods for steam, whether by aid of tables or by aid of Mollier's diagram, can readily be made; even if the blades are "gaged" for constant velocity in a group such allowance presents no special difficulty on the theoretical side. The heat assignment for a group is large enough to be determined from Mollier's diagram, and the fractional proportion for a single stage can be assigned with sufficient precision.

In discussing the difficult subject of balancing, the author says: "Whatever this natural period of vibration [of the loaded shaft] may be, it is easy to understand that, should the rate of revolution coincide with this rate, resonance effects may ensue, augmenting the range of oscillation beyond all limits." May not this be the crux of the whole matter, at least for shafts with considerable rigidity? For then the deflection and the period of vibration can be found, and hence the critical speed.

The author's method of calculating leakage through dummy and gland packings of the type commonly called labyrinth, though subjected to criticism when first published in *Engineering*, appears to be fairly well founded, and deserves careful comparison with experiments. It is to be noted that his equation indicates that a relatively small number of rings should suffice; thus with 150 pounds absolute for the internal steam pressure and atmospheric pressure outside, six rings appear to give only one-twelfth more leakage than thirteen rings. Some experiments at the Massachusetts Institute of Technology (unpublished) indicate that the fall of temperature and pressure takes place principally at the last four or five rings. And yet a large number of rings are used in practice.

High-speed bearings have received more application in connection with steam turbines than in all the rest of engineering work, and are therefore of special interest. The author points out clearly that horizontal bearings for high speeds must run hot, and that reduction of length of bearing appears practicable, though turbine designers have so far been very conservative.

To the designer a collection of dimensioned drawings is of great value, and those given by the author will be appreciated, though caution is necessary, as the author does not, and perhaps cannot, give the limits of the legal protection that the patentees of the various types enjoy. With these drawings are given descriptions of the various turbines, though perhaps we should rather consider the drawings as part of the description. Though this part of the work occupies nearly half the bulk, the author has found it necessary to condense his description—and description of complex machinery, whether or not compressed in space, is very difficult; this is contrary to a common idea that any one who understands a machine can give a clear description of it. Such description may not be classical literature, but if it does not conform to the fundamental ideas of literature it fails of its purpose, which is to convey ideas to the reader with the least resistance.

The book is well printed, finely illustrated and strongly bound. Though there are two lists of errata, not all of the typographical errors have as yet been found. The reviewer, who has received deserved blame for similar delinquency, can only offer his sympathy, for he believes that even the greatest care and solicitude may fail in such matters.

Convenient Handbooks

Engineering Handbook on Patents. By William Macomber. Size, 4⅜ by 6¾ inches. Pages, 288. Boston, 1913: Little, Brown & Company. Price, $2.50 net.

A thorough understanding of what a patent is, what is patentable, how to obtain patents, patent litigation, property rights, etc., would save the expenditure of a good deal of time and money which is now wasted. The handbook which we have under review, while it is addressed especially to engineers, will be found of use to inventors and manufacturers generally. The author of the book, who is a leading patent lawyer and professor of patent law in Cornell University Law School, states in the preface that the book is by no means a treatise on patent law, nor is it a textbook, but that it is simply a handbook in which are presented in simple language, omitting entirely legal phraseology and terminology the theories which underlie successful inventions and which tend to guid the inventor along successful lines. A careful study of this book would undoubtedly enable the user to avoid the lines of thought which have resulted in past failures of other inventors, and will inform him of the steps necessary to secure for himself the full benefits of a successful invention.

Steam Boiler Construction. By Edward G. Hiller. Size, 5½ by 8¼ inches. Pages, 167. Illustrations, 117. Manchester, England, 1912: Taylor, Garnett, Evans & Company, Ltd. Price, 1s.

This book contains the rules of the National Boiler & General Insurance Company, Ltd. (of England), together with notes on material, construction and design of steam boilers and similar vessels. The book is written by the chief engineer of this boiler insurance company, and while the results and notes which he gives embody the principal features of this particular insurance company, they are also based on the experience and experiments of various authorities. The book is, of course, a short one, and much has been omitted that one would expect to find in a comprehensive treatise on boiler construction. The information relates particularly to English practice, which in many essential features is quite different from American practice. Most of the commonly used types of boilers are described rather briefly, including Lancashire and Cornish boilers, vertical boilers, locomotive boilers, marine boilers and the various types of watertube boilers. Some chapters which are of particular value to boiler makers are those relating to riveting, welding, reinforcement of manholes, mudholes and other openings in boiler shells, the staying of flat and curved surfaces and the reinforcement of cylindrical furnace flues, etc. In the final chapter some references are made to the principal boiler fittings.

Book of Standards. (National Tube Company.) Size, 4 by 4½ inches. Pages, 559. Illustrations, 136. Pittsburg, 1913: National Tube Company. Price, $2.00.

For some years the National Tube Company, which manufactures boiler tubes, wrought pipe, water and gas mains, mechanical tubing, miscellaneous forgings and malleable, cast iron and brass fittings and valves, has published at intervals a convenient handbook, in which are given all of the dimensions and data pertaining to the tubular goods which the company manufactures. The handbook which is published this year contains, besides the data regarding the manufactured products, a good many pages of valuable information on certain subjects which are closely related to the uses of pipe and tubes. The engineering data given were obtained in all cases from well-known engineering authorities. Two of the subjects which are of particular value to marine engineers are the strength of pipes under internal fluid pressures and the determination of collapsing pressures on pipes or tubes subjected to external pressure. Separate sections are given to the discussion of the physical properties of gases, the flow of gas in pipes, the properties of steam, both saturated and superheated, the flow of steam through orifices, and the loss of heat from steam pipes. The foregoing are only a few of the many subjects which are discussed in the handbook. In every case the data given are thoroughly up to date, and are presented in a very clear and convenient form by means of tables, formulæ and diagrams which may be readily interpreted. The book has been well indexed and is a convenient source of information for the engineer.

Personal

William E. Waterhouse, naval architect and engineer, has removed his offices to the Whitehall building, 17 Battery Place, New York.

G. P. Stephens, formerly of W. & A. Fletcher Company, Hoboken, N. J., is now in charge of the boiler department of the Skinner Shipbuilding & Dry Dock Company, Baltimore, Md.

Mr. Greensmith, formerly in charge of the machine department of the Newport News Shipbuilding & Dry Dock Company, Newport News, Va., became associated, March 1, with the Skinner Shipbuilding & Dry Dock Company, Baltimore, Md., to take charge of their machine department.

H. McL. Harding, consulting engineer, Department of Docks, New York City, has sailed for Europe to make an extensive study of mechanical appliances employed in the transferring of miscellaneous cargoes and package freight at the river ports and railway terminals. Mr. Harding will also visit many foreign works where freight-handling appliances are manufactured.

Obituary

Sir William H. White, K. C. B., F. R. S., died suddenly, February 27, in London from a paralytic stroke. Born in Devonport in 1845, he began his lifework by entering the Devonport Royal Dockyard as an apprentice shipwright. While there, in 1863, he won an Admiralty scholarship and entered the newly-established Royal School of Naval Architecture at South Kensington. Graduating from the school in 1867 with the highest honors, he entered the Admiralty immediately, and was promoted to the rank of Assistant Constructor in 1875, advanced to Chief Constructor in 1881, and after being associated for two years with the warship building department of Armstrong & Company, he returned again to the Admiralty, becoming head of the Constructive Department, holding the offices of Director of Naval Construction and Assistant Controller of the Royal Navy from 1885 to 1902, when his retirement became necessary on account of ill health. During the seventeen years when he was at the head of the Constructive Department of the Admiralty he was responsible for the design and construction of 245 vessels. Outside of his Admiralty work, Sir William White was for over ten years professor of naval architecture at the Royal School of Naval Architecture, and since leaving the Admiralty he has been identified with many important interests. His book on "Naval Architecture," first published in 1877, has become a classic in engineering literature. He was a liberal contributor to many engineering and scientific societies and always took a leading part in the proceedings of such societies. He had served as president of most of the leading engineering societies in Great Britain, and many honors were bestowed upon him by universities and societies, both at home and abroad.

American Society of Marine Draftsmen.—A meeting of the Delaware River Branch of the American Society of Marine Draftsmen was held in Philadelphia, Pa., March 14, at which Mr. George W. Dickie, naval architect, of San Francisco, Cal., presented a paper on "The Engineer."

ENGINEERING SPECIALTIES

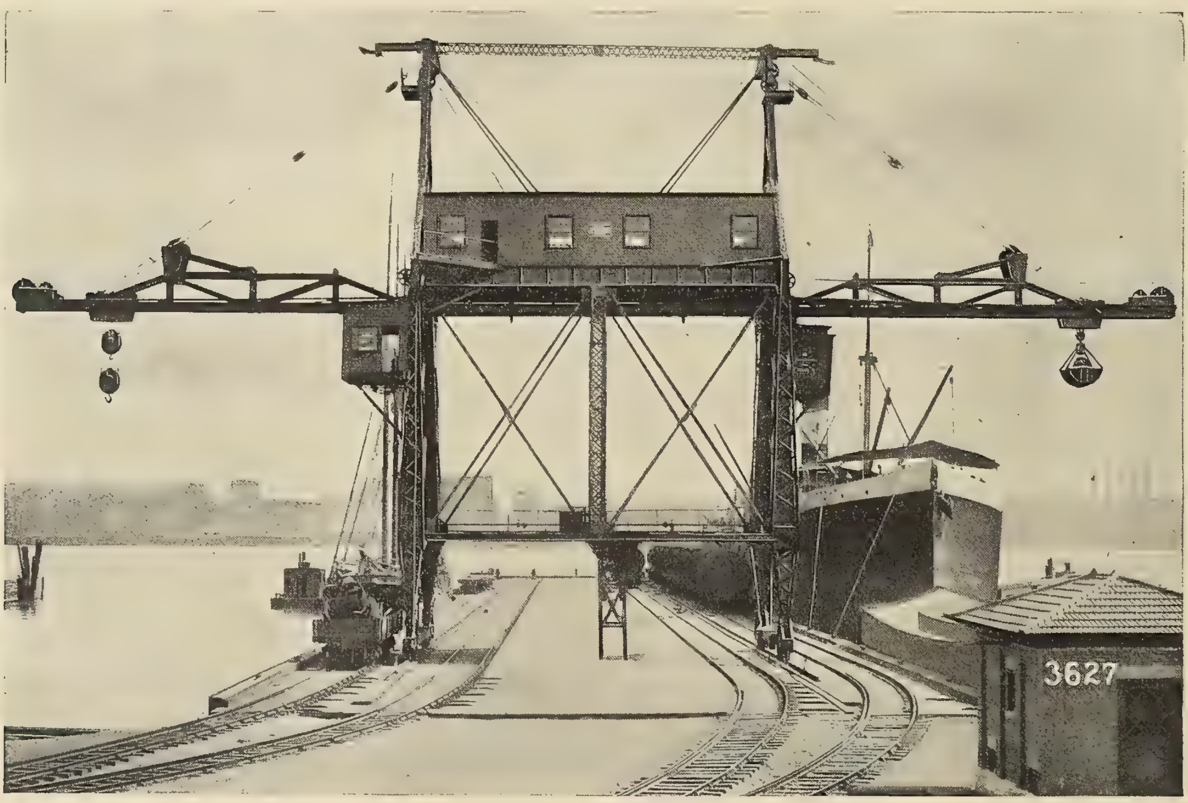
Fay Template Board

The Fay Manilla Roofing Company, Camden, N. J., has on the market a new material especially adapted for template work in shipyards. Laying off by the mold system is generally recognized by shipbuilders as the cheapest method of laying off ship plating, bulkheads, tank tops, frames, etc. In fact, laying off such work from templates made in the mold loft, even when the molds are made of wood, as was formerly the custom, costs only about one-third as much as laying out each piece separately in the yard. Wood templates, however, entail a heavy expense for material and labor, besides encumbering the mold loft on account of the bulk of the material, and so the use of a material such as the Fay template board, which is practically a very stiff, thick paper, specially prepared to resist tearing, distortion or shrinkage from rough usage, makes it possible to reduce the cost of the mold system very materially by the saving in labor and material. Templates made on Fay template board, which is supplied in rolls 105 inches wide, containing 2,000 square feet to the roll, can be rolled up and stowed in racks or bins, where they are ready for use at a moment's notice as often as they are needed.

Tarred Rigging

The use of tarred rigging is now of less interest to the seafaring man than formerly because of the rapid and extensive development of steam power. However, tarred rigging is used to-day on craft of various types to such an extent that the production of tarred goods is an important branch of the cordage industry. The tar best suited for cordage comes from various members of the pine tree family, and is obtained by the distillation process, either by using the old kiln or by modern retorts. It is conceded that the kiln-made article is superior for tarred rigging, and therefore it is used principally in making first quality tarred rope. The tar, as it comes from the kiln, is poured into barrels which are shipped to the cordage works. The way this tar is handled and how it is made to penetrate and adhere to the yarn, as is done by the Plymouth Cordage Company, North Plymouth, Mass., may be described as follows:

The tar is heated to 200 degrees or more in tanks from which the liquid feeds into long copper-lined troughs, where the tarring takes place. Through these "coppers," so called, run steam pipes to further regulate the temperature. Excessive heating would cause the loss of the tar's good qualities, and to prevent this the supply in the "coppers" must be freshened frequently. As the yarns, heavily saturated with tar, come from the "copper" they are compressed between two rollers, adjusted to leave in the yarn as much or as little tar as needed for the particular goods being made and to turn back the surplus. The pull which carries the yarn through the tar and between the rollers comes from two large drums, around which the yarns travel preparatory to reeling on to the friction-driven receiving bobbins. Goods of nine-thread size and under are usually tarred in the completed rope form, but the process is essentially the same as with the yarns. The rich golden brown color of the tarred goods—an outward sign of right materials and methods—has become recognized as the Plymouth mark of the weather-resisting qualities contained in the goods.

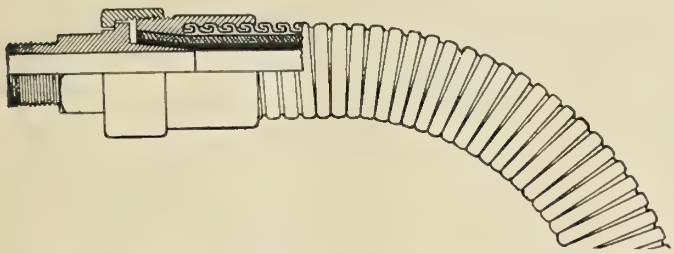


A Direct Unloader

This illustration shows a unique unloading device, designed and built by the Dodge Department of the Link-Belt Company, Chicago and Philadelphia, for the New York Central & Hudson River Railroad at Weehawken, N. J. It is fitted with movable booms and equipped with independent hoisting and trolleying machines for each boom, arranged for operating a 40-cubic foot self-filling bucket for handling coal, ore, sand, sulphur, etc., or it may be equipped with hanging blocks for handling 5-ton or 10-ton loads of miscellaneous materials. Both booms may be operated simultaneously or independently, all of the operations being performed by alternating-current motors.

A New Flexible Hose that Doesn't "Kink"

Users of hose or flexible connectors for steam and pneumatic service have always sought for a high-pressure hose that wouldn't kink, flatten, puncture or collapse at inopportune moments. Troubles of this nature have become so common with ordinary hose that they are accepted as a matter of course, to be dealt with philosophically, just as other vexing problems are met in the course of daily routine, but a new coupling known as the J-M Flexible Metallic Combination Hose has been placed on the market by the H. W. Johns-Manville Company, of New York, which is said to have overcome these difficulties. This connector consists of a superior grade



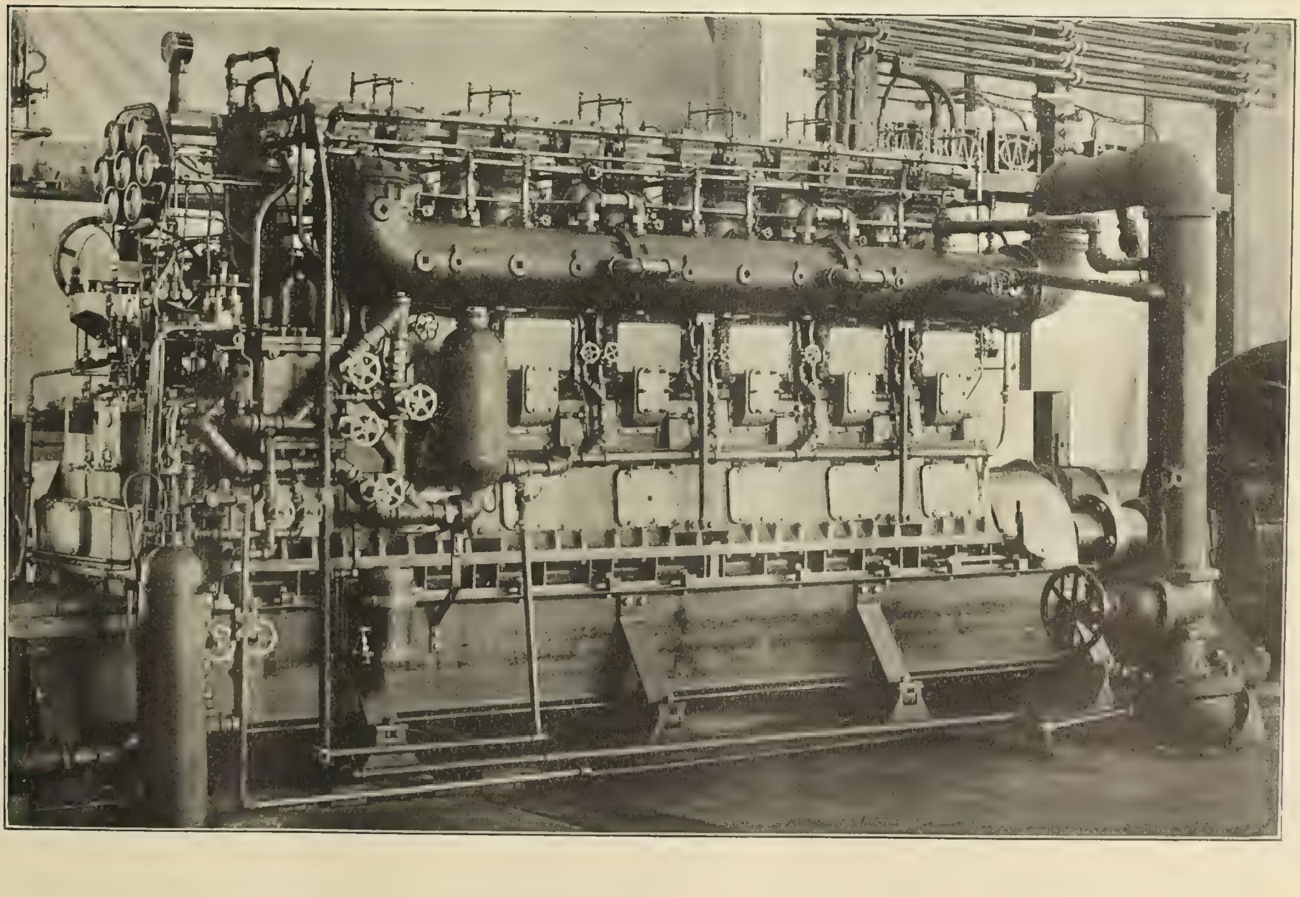
of durable rubber hose, protected against outward injury by a stout metal armor made in the form of a ribbon, with crimped edges, forming, when wound, a continuous, interlocking flexible spiral, which is said to be practically pressure-tight in itself without the inner tube. As the interlocking construction of the spiral restricts the curvature, sharp bends are impossible. Consequently the inner tube cannot kink or flatten, and is always open to its full diameter, permitting an unrestricted flow of steam, gas or fluid. Owing to its unusual strength, the armor is practically proof against damage from the outside, and the substantial construction of the armor permits the use of a much lighter inner tube than is ordinarily used. The exterior surface of the hose, it is claimed, does not become excessively hot when used for steam service, drills, blowing out boilers, etc., and therefore can be conveniently handled under such conditions. Further, there are no rough edges in the metal armor to cut or chafe the inner tube or to cut or scratch the hands of the user.

Specially designed couplings of malleable iron or brass are furnished with each length of hose.

J-M combination hose can be furnished in any length, in any inside diameter up to 12 inches, of any metal, and for all working pressures. It is also made with an inside pressure-tight metallic lining as well as outside metal armor, for suction service, oils, etc.

Full-Power Endurance Test of a 300 Horsepower Marine Diesel Engine

One of the 300-horsepower high-speed Diesel engines, built by the New London Ship & Engine Company, Groton, Conn., for a foreign government was recently placed on the test stand and subjected to a full-power continuous 72-hour run at 500 revolutions per minute. The engine required very little attention during the trial except for the occasional replenishing of the fuel tanks. Although the engine ran for three days and nights at full power there were no indications of undue heating, and, although observations of pressures and temperatures were taken every hour during the test, there was no change from the beginning to the end. The fuel consumption averaged .57 pound per horsepower-hour, which, compared with from 2 to 3 pounds of coal per horsepower-hour usually required in a steam engine, means that the vessel in which this Diesel engine is to be installed can travel on a ton of oil from four to five times the distance it could travel on a ton of coal if fitted with steam engines. The consumption of lubricating oil was about 1 gallon per hour. No attempt was made to economize on the consumption of lubricating oil, for the reason that the test was considered very severe; in fact, this is believed to be the longest full-power endurance trial ever made on an engine of the same general type, and the performance of the engine speaks well for the excellency of the work turned out by the builders.



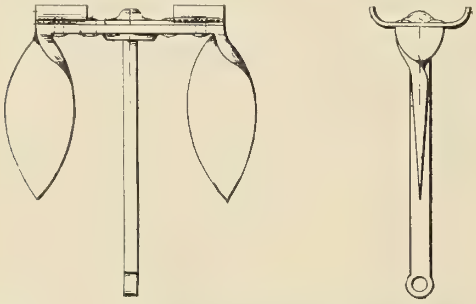
SELECTED MARINE PATENTS

The publication in this column of a patent specification does not necessarily imply editorial commendation.

American patents compiled by Delbert H. Decker, Esq., registered patent attorney, Loan & Trust Building, Washington, D. C.

1,047,155. ANCHOR. SEELEY P. BIRDSEY, OF MIDDLETOWN, CONN., ASSIGNOR TO WILCOX, CRITTENDEN & CO., INCORPORATED, OF MIDDLETOWN, CONN., A CORPORATION OF CONNECTICUT.

Claim 1.—In an anchor, the combination with a member, made of a single piece of forged or rolled metal, terminating at both ends in a fluke bent at substantially a right angle to the intermediate portion; of



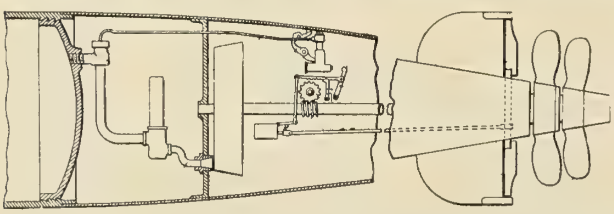
a plate secured to said member substantially parallel with said intermediate portion and forming a reinforcement therefor; and a shank pivotally connected between said member and plate. Five claims.

1,048,068. BOAT SADDLE. ELIAS GUNNELL, OF MANITOWOC, WIS.

Claim 1.—In a boat saddle, the combination with a base, of a pair of cross-arms pivoted together and resting for relative movement on the base, and flexible members secured to the lower ends of the cross-arms provided with means adapted to engage the edges of the boat. Eighteen claims.

1,044,543. STOPPING DEVICE FOR AUTOMOBILE TORPEDOES. FRANK M. LEAVITT, OF SMITHTOWN, N. Y., ASSIGNOR TO E. W. BLISS COMPANY, OF BROOKLYN, N. Y., A CORPORATION OF WEST VIRGINIA.

Claim 3.—In a torpedo, a timing device comprising a traveler moving from a starting to a stopping point, means for stopping the normal run



of the torpedo operated when such traveler reaches its stopping point, and means operated from the steering mechanism and adapted to stop the movement of the traveler and restore it to its starting point. Nine claims.

1,046,675. BOAT-HANDLING DEVICE. GEORGE W. SWEDENBORG, OF ASHTABULA, OHIO.

Claim 1.—In a device for handling boats, the combination with a vessel having an upper and a lower deck, of a davit pivoted upon the upper deck, a boat suspended from the davit outside of the vertical through the davit pivots so as to tend to cause the davit to swing upon said pivots, means operable from the lower deck for normally holding the davit against such swinging movement, mechanism for controlling the swinging movement of the davit, such movement bringing the boat substantially opposite the lower deck and means adapted to be under control of persons in the boat for lowering the latter below the lower deck. Seventeen claims.

1,050,058. GAS BUOY. NELSON GOODYEAR, OF NEW YORK, N. Y., ASSIGNOR TO BROOKS H. WELLS, OF NEW YORK, N. Y.

Claim 1.—In a gas buoy the combination of a body or float having a chamber carried by the float open to the sea water, and means controlled by the level of the water in said chamber for feeding carbide to water. Forty-one claims.

1,050,045. SELF-RIGHTING AND SELF-BAILING BOAT. EINAR L. M. SIVARD, OF BROOKLYN, N. Y., ASSIGNOR, BY MESNE ASSIGNMENTS, TO ASTOR TRUST COMPANY, TRUSTEE, A CORPORATION OF NEW YORK.

Claim.—In a self-righting boat, the combination with air-tight compartments on each side thereof, of a longitudinally-extending tank having sides inclining from the bottom of the boat toward the center line of the deck so as to form a tank substantially triangular in cross-section, a valve in the bottom of the tank adapted to open automatically to admit water thereto and to close to keep the water in, and an independent air-escape valve normally retained in open position to permit the escape of air during the filling of the tank and adapted to close to retain water within the tank when the boat is capsized. One claim.

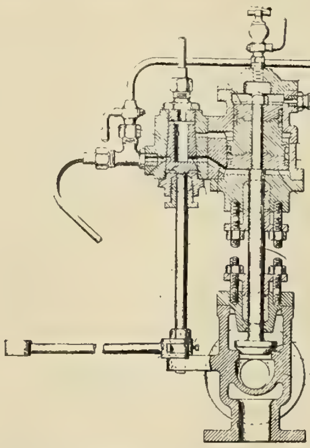
British patents compiled by G. F. Redfern & Company, chartered patent agents and engineers, 15 South street, Finsbury, E. C., and 10 Gray's Inn Place, W. C., London.

26,136. IMPROVEMENTS RELATING TO THE PROPULSION OF VESSELS. J. I. THORNYCROFT & CO., LTD., OF WOOLSTON WORKS, WOOLSTON, HANTS.

In connection with the propulsion of ships by turbines and internal combustion (Diesel) engines with means for enabling the same to be used alternatively for high and low speeds respectively in order to reduce the power absorbed by the turbine plant when the Diesel engines are propelling, a branch pipe leading from near one end of the exhaust receiver of the Diesel engine is connected to a steam generator of any known or suitable type so as to utilize the heat of the hot exhaust products of combustion from the engine for generating steam which is admitted to the turbines (not shown), any steam in excess being used in the engine driving the air pumps or other auxiliaries.

28,819. STEAM STEERING GEAR. T. GRIEVES, OF WATERLOO VILLAS, BLYTH, NORTHUMBERLAND.

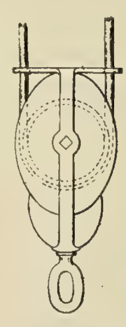
The invention relates to the control of the steam admission valve of steam steering gear for ships. The movements of the steering wheel are imparted to an arm giving a partial turn to the rod of a ported valve to put the inlet passage in communication with the port of the cylinder so that steam is admitted below the larger diameter of the piston and exhausted from the upper side of the piston. The steam so admitted overcomes the constant steam pressure in the space above the



lesser diameter of the piston and thereby forcing the piston up and raising the control valve which admits steam to the engine. When the valve is brought back into mid-position with the exhaust passage in communication with the steam port the steam is exhausted below the piston and the constant pressure above again forces down the piston and closes the control valve.

11,461. SAFETY BLOCK FOR BOAT FALLS. E. EKBLOM, OF 76 AVENONS ROAD, PLAISTOW, LONDON.

This invention relates to improved safety blocks for use with boat falls, the object being to provide such blocks with means which will prevent them turning over when the weight of the boat is removed. To



this end each bottom block is provided at its upper end with a guide plate through holes in which the ropes pass. A weight may be provided, and for connecting a pair of blocks together side extensions may be provided.

27,629. IMPROVED SELF-DISCHARGING VESSEL OR BARGE. C. I. DAVIDSON, BILLITER STREET, E. C.

This invention provides a new or improved form of self-discharging vessel or barge by means of which fuel or other substances may be placed on board other vessels or barges or on shore. This invention consists in the provision of V-shaped depressions having semi-circular troughs in their bottom angles formed by the bottom of the hold and fitted with screw conveyors for trimming the cargo to a well formed in the hold from which the cargo is raised, elevating bucket dredgers and from the elevating element, screw conveyors carrying the cargo to the required point of discharge. The discharging conveyor is fitted in a carriage capable of slewing the conveyor vertically, horizontally and also running it inboard and outboard. Portable screw conveyors for carrying cargo from the discharging conveyor to a further point inaccessible to the discharging conveyor, may be provided.

International Marine Engineering

Published Monthly by ALDRICH PUBLISHING CO.

17 BATTERY PLACE, NEW YORK — 31 CHRISTOPHER ST., LONDON, E. C.

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Edited by H. H. Brown, A. M. Inst. N. A.
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Vol. XVIII — MAY, 1913 — No. 5

Hydraulic Suction Dredge for Canal Work

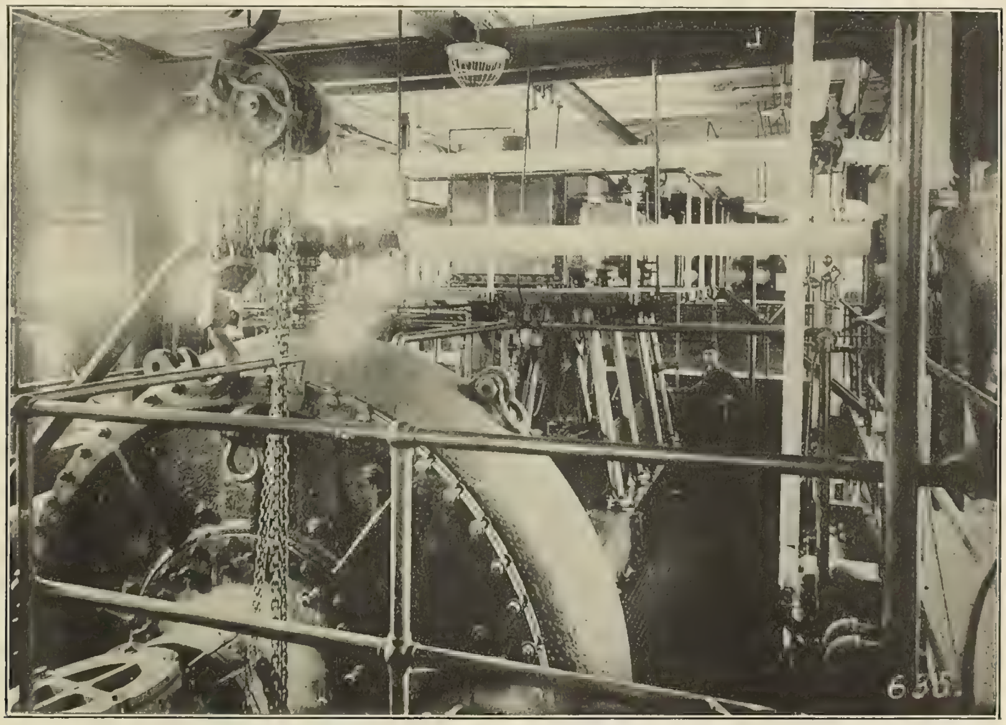
The Morris Machine Works, Baldwinsville, N. Y., during the past year has built for the American Pipe & Construction Company a 20-inch hydraulic suction dredge for use at Amsterdam, N. Y., on one of the New York State Barge Canal contracts. The dredge has a wood hull of the following dimensions: Length, 137 feet 8 inches; breadth, 40 feet, and depth, 10 feet 2 inches.

The main dredging pump is made throughout of manganese steel, with an average thickness of 3¼ inches. It is unlined around the periphery. The main pump shell is fitted with removable side disks, which are lined with manganese steel circular plates on their inner faces. The runner is also of manganese steel, with five vanes, and is 90 inches in diameter, mounted on a steel shaft 10 inches in diameter. The pump is operated at speeds up to 225 revolutions per minute, and easily maintains a discharge pressure on the pipe line of 60 pounds per square inch. Both the suction and discharge are 20 inches diameter.

The triple expansion engine, which is directly connected to the pump, has cylinders 17 inches, 27½ inches and 42 inches in diameter, with a common stroke of 20 inches. It is capable of delivering 1,000 horsepower. The engine is of open-frame type, giving full view of all the working parts, and all parts throughout are of exceptionally heavy proportions to operate without ceasing at high speed, and with a working steam pressure of 200 pounds per square inch. A water-cooled multi-collar marine thrust bearing is provided to take the unbalanced end thrust of the dredging pump.

The pump and engine are mounted together on a cast iron sub-base, which in turn rests on a structural steel base built up from the bottom of the dredge hull.

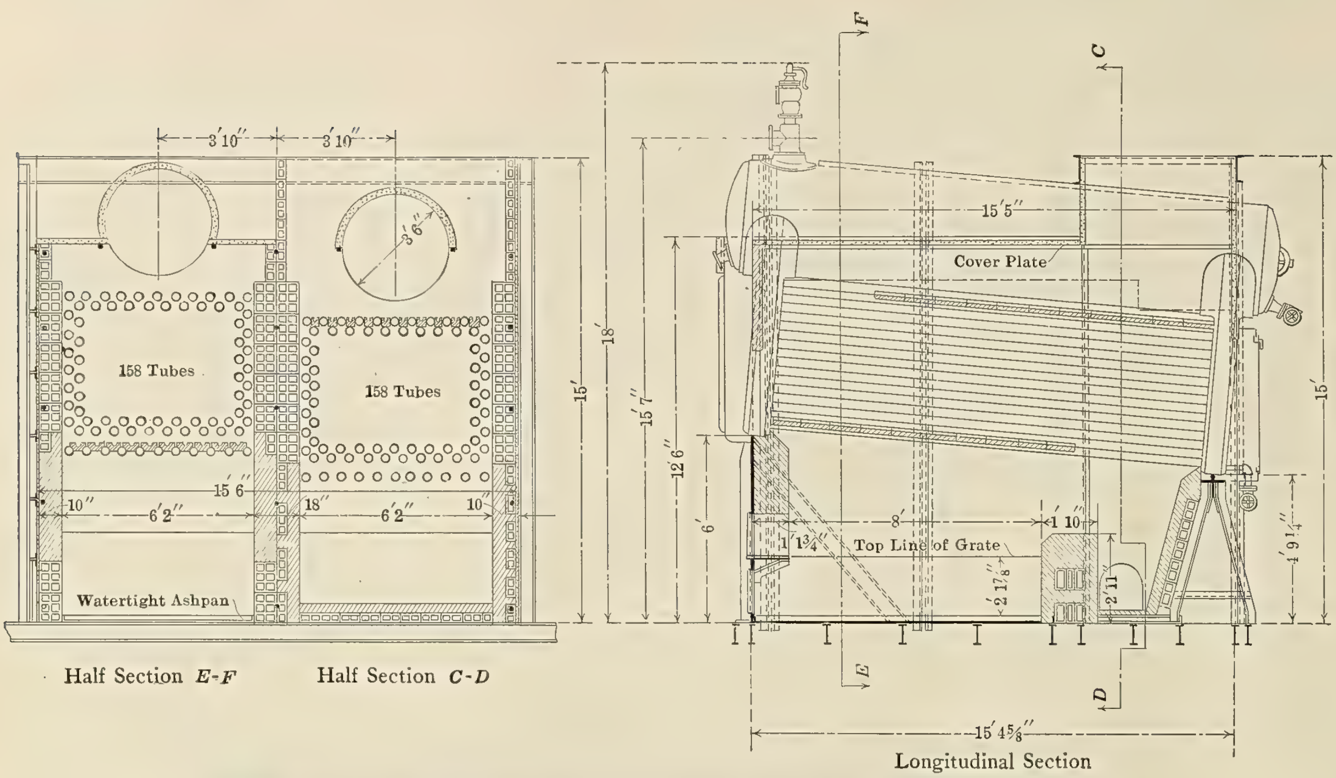
The cutter ladder, which is 50 feet long, is mounted within a ladder well in the bow of the dredge. The ladder is made throughout of structural steel of very heavy proportions. The ladder driving shaft is made of steel 8½ inches in diameter, supported in babbitt-lined bearings with removable shells. A multi-collar thrust bearing of marine type holds the ladder shafting in perfect position.



MAIN DREDGING PUMP DRIVEN BY TRIPLE-EXPANSION ENGINE

The normal speed of the cutter shaft is 12 revolutions per minute. The cutter shaft is driven through cast steel cut gearing from a 12-inch by 12-inch horizontal double engine running at about 225 revolutions per minute.

The boiler equipment consists of four Heine watertube boilers, each of 225 horsepower, carrying steam at 200 pounds pressure. The boilers are arranged in two batteries facing together and have two smokestacks. Forced draft is used.



DETAILS OF ONE OF THE 225-HORSEPOWER HEINE WATERTUBE BOILERS INSTALLED ON THE CANAL DREDGE

The winding machinery consists of an 8¼-inch by 12-inch double cylinder compound-geared Flory engine, with cast steel framing, drums and gears, and of heavy construction throughout. The swinging drums are 24 inches diameter, the ladder hoist and spud hoist are 20 inches in diameter.

The machinery equipment includes a surface condenser having 2,000 square feet of cooling surface, with two 8-inch discharge centrifugal circulating pumps so arranged that they can deliver through the condenser in opposite directions, only one pump being in service at a time. The air pump is of the vertical twin beam type 7½ inches by 16½ inches by 10 inches. The auxiliary equipment also includes a 15-kilowatt direct connected generator.

HYDRAULIC SUCTION DREDGE AT WORK ON THE NEW YORK STATE BARGE CANAL

Seagoing Suction Dredge Col. P. S. Michie.—The Seattle Construction and Dry Dock Company, Seattle, Wash., has under construction for the United States Engineer Office of the War Department a twin screw seagoing suction dredge of the central well type, which is to be put into commission in May of this year. The dredge, which is named the *Col. P. S. Michie*, is 230 feet long by 43 feet beam. This company, which has one of the best equipped shipyards on the Pacific Coast for the manufacture of various types of dredging machinery and equipment, has built a large variety of suction, bucket, dipper, clamshell and orange-peel dredges, including the largest clamshell dredging equipment employed on the Panama Canal, besides many other important installations.

An 8-Cubic Yard Dipper Dredge

One of the most modern and best-equipped dipper dredges on the Great Lakes will be put in operation this spring by the Fitz Simons & Connell Dredge & Dock Company, of Chicago. The hull, which is steel throughout of exceptionally rigid construction, was designed and built by the Manitowoc Ship Building & Dry Dock Company, Manitowoc, Wis., and the machinery, including the A-frame, boom, swing circle and dipper, all furnished by the Bucyrus Company, of South Milwaukee, Wis., was installed at the same place.

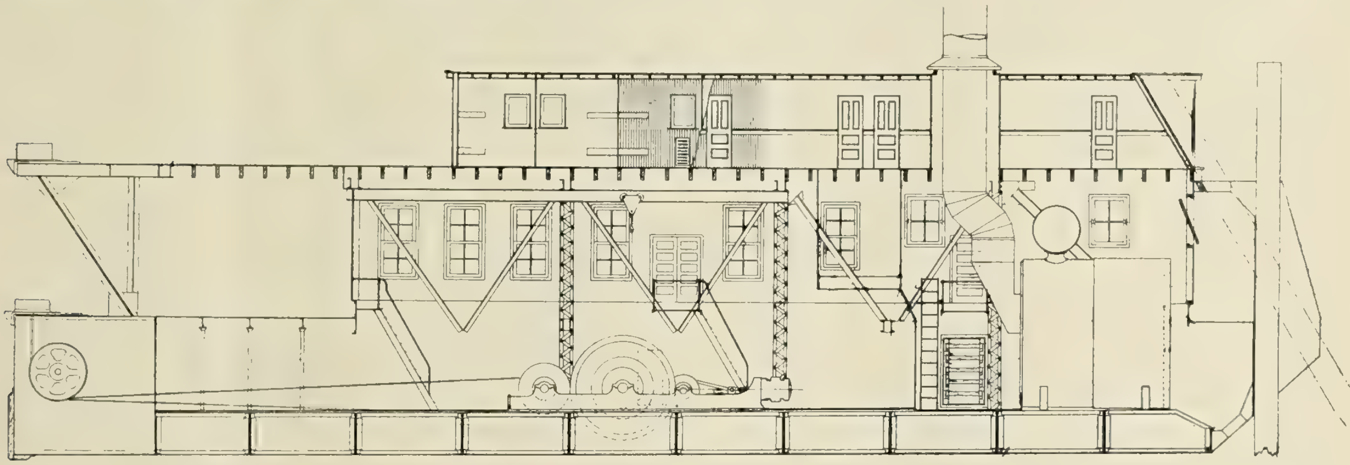
The general dimensions of the dredge are: Length, 110 feet; beam, 40 feet; depth, 11 feet 6 inches forward and 10 feet 6 inches aft. The bottom framing consists of floors 42 inches high spaced 9 feet, extending from side to side of the hull. Between these floors there is light channel framing. Two 42-inch fore and aft plate engine girders run the full length of the dredge, and are cut and clipped to each high floor. In place of the usual trusses below the main deck this dredge has two watertight bulkheads extending from stem to stern. Necessary openings through the bulkheads are equipped with watertight doors.

In line with the spud casings, which are set back 10 feet from the bow, there is an athwartship watertight bulkhead which not only takes the racking strains at the spuds, but forms a watertight compartment at the forward end. This compartment serves the purpose of protection in case of damage, and can be used for water ballast should it be found advisable to pin up harder than usual in some classes of digging. The coal bunkers are in the wing compartments abreast of the boiler.

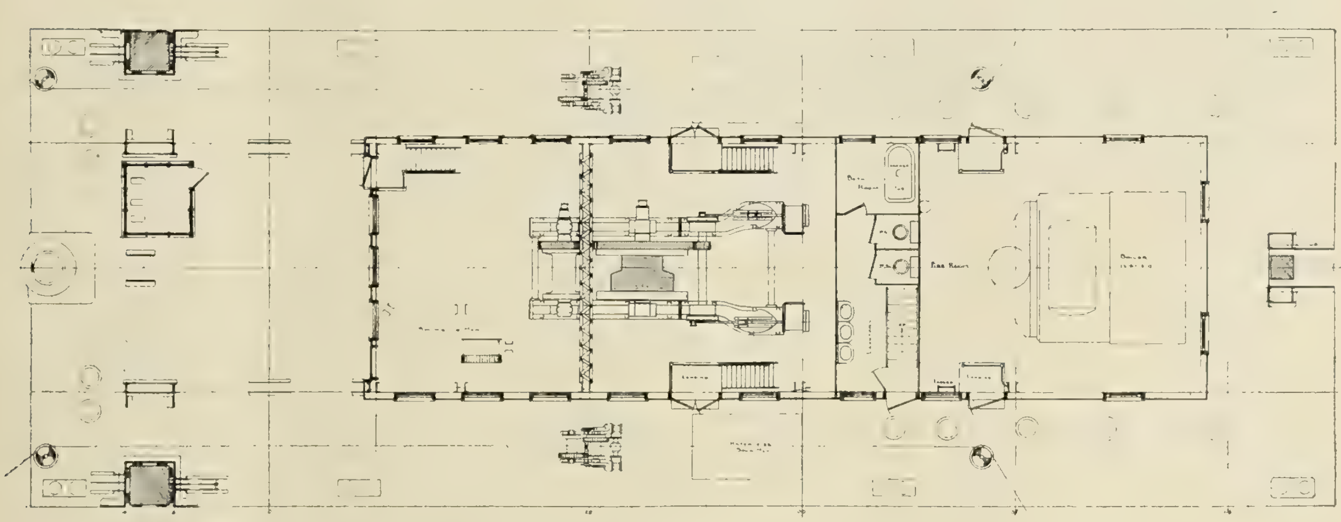
The trusses above the deck extend the full length of the dredge and the stanchions and diagonals are secured to the longitudinal bulkheads. Stanchions and chords are double channel, latticed together.

The spud casings are 44 inches square and extend to the top of the truss, to which they are fastened and braced. The forward end of the truss forms the foundation for the swing circle and A-frame.

There are two oak wale strakes on each side of the hull, with vertical pieces chocked between, spaced 9 feet, to take the roll of the fender log. There is in addition a fender at the forward end below the water, built of oak and faced with plate to take the shock if the dipper should be brought back against the hull.



INBOARD PROFILE



MAIN DECK

The forward spuds are 40 inches by 40 inches Oregon fir sticks in one piece, and the wear is taken by oak rubbing strips spiked onto all four sides, and which can readily be replaced. The after spud is 20 inches by 20 inches fir, operated by a rack and pinion.

The main engine is a double 16-inch by 18-inch engine, geared directly to a differential hoisting drum which is grooved to take wire rope. The same engine drives the backing drum, which also takes wire rope. The two drums are driven through outside band frictions actuated by steam cylinders. All the gears and the drums are cast steel.

The two spud engines, which are placed in the wing compartments, are 9-inch by 9-inch double-cylinder reversing engines, with steel drums and gears. A powerful steam-operated brake is provided on the intermediate shaft to hold the dredge when pinned up. The bed plates are of structural steel.

The swinging engine is a double 9-inch by 9-inch engine with cast steel drum and gears. The drum has double-threaded machined grooves for two parallel swinging ropes.

The boom, swing circles, A-frame, are of heavy structural steel, fitted with steel castings, and the various sheaves throughout are cast steel. The dipper, which is also supplied by the Bucyrus Company, is of heavy construction, provided with forged teeth and is operated by a steam dipper trip.

The stern spud is operated by a 9-inch by 9-inch center valve reversing engine which drives the spud hoist shaft by means of a chain and sprockets. The spud is raised by a pinion which meshes with a rack on the spud.

The operating levers are well forward on the dredge, situated in a small operating room, and control practically all the machinery.

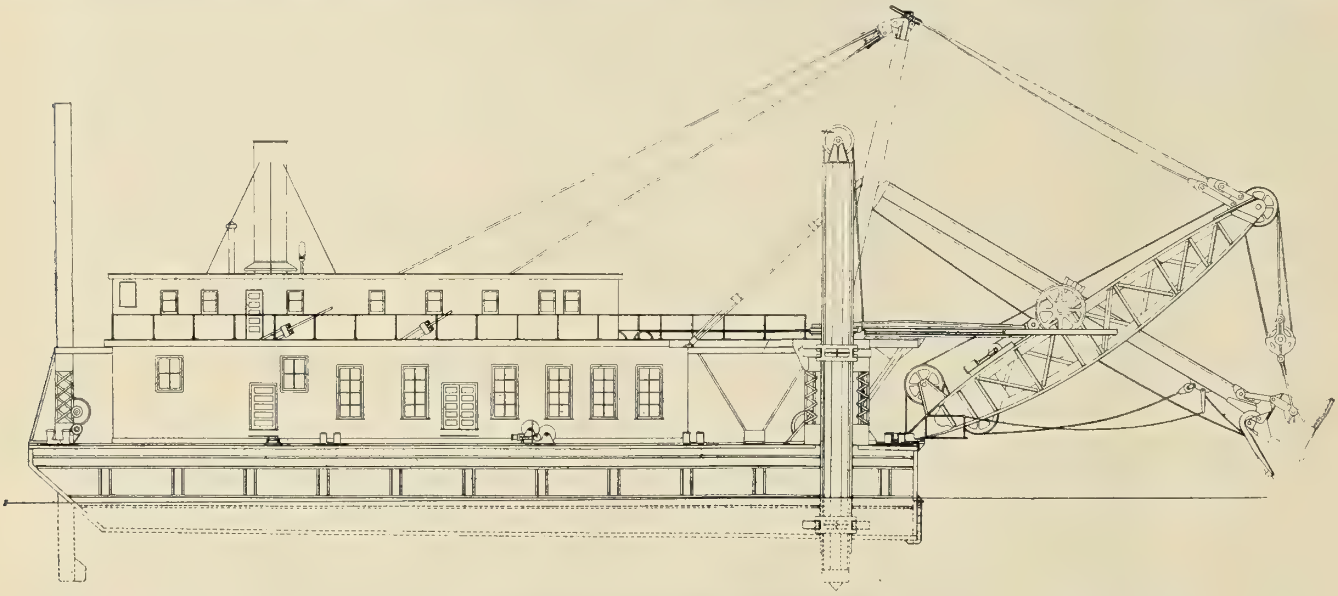
The boiler is of the Scotch marine type, 12 feet 6 inches diameter by 12 feet long, built for a pressure of 150 pounds. There are two 50-inch Morison corrugated furnaces and 254 3-inch tubes. The boiler is further equipped with a 4-foot by 8-foot steam dome. The builders are the Manitowoc Boiler Works Company, Manitowoc, Wis.

The deck houses are built of wood, the roof of the lower house resting on the truss. This house completely encloses the machinery hatch and is lighted by large windows. The upper house contains all the sleeping rooms and the kitchen and dining room, and is ceiled throughout inside with yellow pine, varnished, and the quarters are light and roomy. The berths are all steel.

The lavatory is in the lower house and is equipped with modern plumbing, including a bath tub, shower, sanitary pump and water heater, and all the quarters are heated by steam.

For handling the scow lines there are two Chase double cylinder 6-inch by 6-inch tandem double drum winches with wire lines which lead around roller bearing fair leaders.

Tank Steamer Vesta.—The Standard Oil Company's steamer *Vesta,* built by the New York Shipbuilding Company, Camden, N. J., was taken out April 5 for a trial trip on the Delaware River, meeting the requirements of her owners in every particular. The ship is 330 feet long, 46 feet beam, 27 feet depth and carries 30,000 barrels cargo oil. Before completion the vessel was changed to an oil-burning steamer.



OUTBOARD PROFILE OF 8-YARD DIPPER DREDGE

Dredgers for Gold and Tin

Dredgers for recovering alluvial gold have been in use for many years. In our special dredging number of May, 1910, we published illustrations and an article describing the latest gold dredgers supplied by Mr. Arthur R. Brown, of 54 New Broad street, London, to various parts of South America, Africa, Russia and Siberia. Since that date the demand for dredgers for gold has very much increased, and many improvements have been introduced by Mr. Brown in the dredging machinery and gold-saving plant, so much so that his dredgers in Russia now work (in spite of severe frosts) practically the whole year round; those in the Urals have averaged 20 hours a day for 280 days per annum. The great advance made by Mr. Brown's dredgers will be better understood from a glance at the Russian Government returns, which show that the usual number of days worked in that country is only 170 days a year and about 15 hours a day.

The Lena district of Siberia has proved to be exceptionally rich in free alluvial gold, and very large returns have been received by the English shareholders of the well-known Lena Goldfields Company; so far these properties have been worked entirely by manual labor, the gravels being dug, raised in baskets and washed by hand.

Mr. Brown has just completed some large gold dredgers, which will be the first to be used in that district, and when they can get to work exceptional results are confidently expected. The transport, however, is very costly and takes time. The whole of the machinery has to be transported about 5,000 miles by rail, then about 300 miles by sledge, and then 800 miles by river. In order to insure the parts of the dredgers being transported by sledge before the snow melted, it was necessary for the whole plant to be shipped within three months from date of order. Although the dredgers were dispatched from England in February, they cannot arrive at their destination until about the middle of next June. In this district dredgers only have a possible 170 days for work, being frozen up the rest of the year, but it is expected that they will be in time to have a few weeks work this year.

Although dredgers have been used for many years for recovering gold and also for some time for platinum, it is only recently that they have been used for saving tin. They have proved most successful in saving this metal, although it is more difficult than gold on account of its lower specific gravity. A dredger for tin is constructed very much in the same way as for gold, with the exception that the saving tables have to be much larger and more water is required.

The latest improved tin dredger, illustrated below, is at work near Penang in the Malay States. This dredger, which was built by Mr. Brown for the Malayan Tin Dredging, Ltd., of London, started work in January last, and although for the first month it was chiefly opening up ground, sufficient tin was recovered to leave a profit after paying all expenses of nearly $9,750 (£2,000). When, however, it gets into full work the net profit is expected to reach $19,500 (£4,000) monthly.

This dredger, which is the largest dredger for tin so far constructed and at work, has buckets of 10 cubic feet capacity and dredges to a depth below water level of 50 feet. The steel pontoon on which the machinery is placed is 150 feet long, with an elevator extending beyond the stern a further 116 feet. A special feature of this dredger is that it is fitted with apparatus for removing the overburden and depositing it at a considerable distance behind the stern of the dredger, without passing through the screen or over the tables.

IMPROVED TIN DREDGE AT WORK IN THE MALAY STATES

The motive power is steam and the engines are of a specially balanced type. The water supply for washing the material, as is necessary for tin, is exceptionally large, and the tables for saving the tin extend the whole width of the dredger and are 90 feet long.

Hydraulic Dredge Ithaca

BY R. R. ROANE, M. E.

The New York State Dredging Corporation, Rochester, N. Y., has completed a large 20-inch hydraulic dredge at Ithaca, N. Y., for work at a terminal of the New York State Barge Canal, known as improvements of the Cayuga and Seneca Canal, Contract "H," calling for 700,000 cubic yards of excavation and for the harbor work in connection with the barge canal at Ithaca, which calls for 62,300 cubic yards of excavation, making the total excavation 762,300 cubic yards.

The dimensions of the dredge are: Length over all, 137 feet 6 inches; beam, 40 feet; depth, 10 feet, and mean draft, 5 feet. There are two structural steel trusses running fore and aft for the whole length, the machinery being set upon steel foundations designed especially for the requirements.

The main pump and thrust bearing were designed and built by the Morris Machine Works, Baldwinsville, N. Y., the runner of the pump being 90 inches in diameter, of manganese steel. The pump is driven by a triple expansion engine 18 inches by 30 inches by 48 inches by 20 inches, designed by the New York Ship Building Company, Camden, N. J. This engine, while designed for 1,000 horsepower, is now being used only at a speed of 190 revolutions per minute with a cut-off of 66 percent of stroke, developing 750 horsepower.

Steam is furnished by four boilers, two of the Mosher watertube type, operating at 200 pounds steam pressure for the main engine and feed pumps alone, and two of the fire-tube Bigelow type, operating at 125 pounds steam pressure reduced to 100 pounds for all auxiliary machinery.

The dredge carries two main feed pumps 8 inches by 5 inches by 12 inches of the Blake vertical simplex type, a surface condenser of 1,750 square feet cooling surface, a main circulating pump 10 inches by 6 inches by 6 inches, an auxiliary circulating pump of the Blake horizontal duplex type 12 inches by 12 inches by 12 inches, an air pump of the Blake twin beam type 7½ inches by 15 inches by 10 inches, one feed-water heater and grease extractor, one filter tank, two water service pumps, one 6-inch by 6-inch by 6-inch vertical duplex Blake and one 8-inch by 5-inch by 12-inch horizontal simplex Blake, both connected in duplicate to supply the main engine water service, the cutter engine water service, the fire line bilge system and for discharging ashes. There is an auxiliary feed pump for the auxiliary boilers and a Hancock inspirator; one fresh water pump 5¼ inches by 5 inches by 5 inches of the Blake vertical duplex type to draw from the scows and discharge to tanks, or vice versa.

20-INCH HYDRAULIC DREDGE ITHACA

The winding engines are of the Chase machine type with five drums. The ladder is of steel, designed by the Norbom Engineering Company, and the cutter engine is of the horizontal type designed by the Norbom Engineering Company, mounted directly on the ladder driving the cutter shaft through spur gears. The cutter blades, designed by the Taylor Iron & Steel Company, are of manganese steel.

LAUNCH OF THE UNITED STATES TORPEDO BOAT DESTROYER DUNCAN.—The United States torpedo boat destroyer *Duncan* was launched at the works of the Fore River Shipbuilding Company, Quincy, Mass., April 5. The vessel is one of eight contracted for by the United States navy in September, 1911, and is to be completed by September next. The keel was laid in June, 1912, and she will make her first preliminary trial trip about May 15, 1913. The *Duncan* is 305 feet long, 30 feet 6 inches beam, 17 feet depth, with a mean trial displacement of 1,010 tons. She carries a battery of four 4-inch guns and four 18-inch torpedo tubes. The propelling machinery, of 16,000 horsepower, consists of two 63-inch Curtis turbines and two compound, vertical reciprocating engines, designed to give the vessel a speed of 29 knots.

Dredging

BY M. G. KINDLUND *

In this article attention is to be paid principally to the methods in general use for attacking the materials to be dredged, or loosening them from the bottom, so that they may be brought to the surface for disposal. The methods employed are numerous and depend principally upon the nature of the bottom, and secondarily upon other conditions, such as depth of water and manner of transporting the spoil. As every dredging operation must necessarily include a study of the materials to be removed, it would be well to review the various soils that are ordinarily found, and note some of their characteristics, at the same time indicating the best means of dealing with them.

Mud, or silt, forming the bottoms of many rivers and harbors is composed of powdered mineral and vegetable matter, the mineral resulting from the disintegration of soft rock. It is easily carried in suspension by running water, and so is found at the mouths of rivers, where the slower current, or the encountering of tidal waters, allows it to deposit.

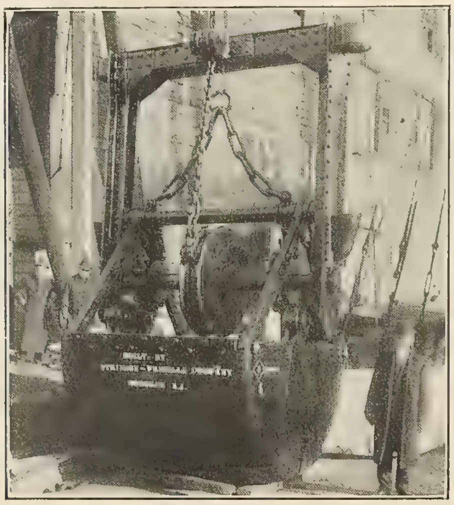


FIG. 1.—CLAM-SHELL BUCKET

Being more or less pasty in nature, the particles stick to one another during the course of removal, which facilitates handling when accomplished by an agency that does not stir up the bottom to too great an extent. However, once it is thoroughly stirred up, it takes a long time for it to settle again, often resulting in considerable loss of time. Layers of mud can be easily penetrated by a bucket, and as it is advisable, as before mentioned, to engage large quantities at one operation with little commotion, the grab bucket of fairly large capacity has been extensively employed for the purpose. The clamshell type of grab is the best, as it closes more effectively than the orange-peel and allows less leakage after being raised above the water.

Fig. 1 shows a clamshell bucket of about 7 cubic yards capacity, made by Atkinson-Frizelle Company for work in Havana harbor. It is a type very generally employed for dredging on the Atlantic Coast, and is constructed to stand the hardest kind of service. For mud the degree of penetrating power is not important, the main consideration being capacity and speed of operation. One evident feature of this method of dredging is that there is no limit to the depth of water; all other methods have limits set by questions of construction and obedience to Nature's laws, whereas, with the grab bucket, increased depth of digging may be provided for by more rope or chain and larger winding drums, the hull and engine remaining about the same for a given capacity. The bucket shown is of large size, weighing empty about 22,000 pounds, and filled with average material about 43,000 pounds. Clamshell buckets of the same kind have been built up to 12 cubic yards capacity, the principal difference in construction being the provision of two power wheels instead of one, not only to gain greater closing power, but also to overcome any tendency of the bucket to twist in raising and lowering. This 12-yard clamshell was built by Theo. Smith & Sons Company for the dredge *Finn MacCool*, one of the most powerful dredges in existence. This huge bucket weighed about 38,000 pounds empty and approximately 75,000 pounds filled with average material, requiring four 1¼-inch steel cables for its operation, wound on two 60-inch drums, the main hoisting engine being an 18 x 24-inch double cylinder engine, using steam at 125 pounds pressure.

Hydraulic suction dredges are often called upon to work on a muddy bottom. It would seem an ideal method, and is so if the suction head is designed to limit the water entering the pipe. The material goes into the suction quite easily, either with or without the use of cutters, but, during its progress through the pump and discharge pipe, the objectionable stirring-up of the particles of silt before referred to takes place, so that at the point of discharge the mixture resembles a black puree, that, unfortunately, remains a soup for some time. Gravity acts very slowly upon the light particles, and a portion of the material, sometimes a considerable portion, runs back into the river with the transporting water. Whether discharge takes place into the hoppers of the dredge itself or on the fill behind sheet piling, the same disadvantage is present. Thus, if 20 percent mud and 80 percent water enter the suction pipe, taking a favorable case, perhaps 5 percent or more will find its way back to the waters it came from, so reducing the economy of the operation by at least 25 percent.

Special suction heads are sometimes used for handling such slippery material, so designed that the mud is ploughed up and enclosed on top and sides; then water is supplied by artificial means only in sufficient quantities to make it possible for the suction to move the mass. It is really, then, a semi-solid mixture, in which the relative proportions of mud and water are often reversed as compared with the open suction pipe system. For a hopper dredge this method is ideal, but is obviously less applicable to cases where discharge takes place through long pipe lines. Unless some such device as this be used, it is often better to leave mud to a clamshell dredge, transporting it by means of dump scows. Of course a suction dredge may be profitably employed for reclamation purposes, where the area to be reclaimed is of large extent and sufficient time is given the released mixture to allow the solid portion to deposit before regaining the channel.

The next soil, as regards ease of handling, is sand, varying from the finest to the coarsest grained. It is very common to find mud and sand in the same locality, the preponderance of one or the other indicating the best means of dealing with it. In some rivers and harbors, and usually in the more open work of sounds and seacoast, sand is the material encountered. Owing to the comparative magnitude of such dredging operations—removing sand bars, making and maintaining deep waterways—the removal of sand assumes the greatest importance among the many duties of a dredge. Generally speaking, sand is formed by the abrasive action of fragments of

* Engineer, 17 Battery Place, New York.

hard rock grinding against one another in the beds of brooks and rivers and under the ever-moving waters of the sea shore. It is composed of fine quartz grains, usually mixed with other resisting minerals. The softer rocks are quickly ground into mud. When newly formed, the particles are angular and sharply pointed, and they may be classified as coarse or fine, according as the grains have been reduced to a large or small size.

For handling this material the hydraulic suction dredge stands without a rival, particularly where the quantity involved is considerable. Sand may be broken up quite readily with the aid of various devices to be described, although, when lying under deep water, the pressure packs it into a fairly solid mass. It lacks the cohesion of mud and clay, so a stirring-up process is comparatively easy and not objectionable, as the grains, being heavy, will quickly gravitate to the bottom of the hoppers or become stationary on the fill, leaving the transporting water free to find its way into the channel. When very fine sand is encountered it is a somewhat different story, owing to its lightness and consequent tendency to resist settling quickly. The grains become scattered very easily and float away, often giving as much trouble as silt, while lacking the cohesive qualities of the latter, when in bulk.

Of course any type of dredge will excavate sand under water, but there is none that will do it as economically and as expeditiously as the suction dredge. Sometimes nothing but the force of the suction at the end of the pipe is employed to release the sand, and under favorable conditions this does quite well. However, it is usually the best policy to fit some kind of an agitating apparatus, either mechanical or jets of water under pressure. The latter, used in connection with a special suction head, forms, perhaps, the most effective means of breaking up the material. The Government engineers, during their experience on the Mississippi River, have tried many forms of mechanical agitators, but have always come back to the water jets as offering the simplest and most direct means of accomplishing the result. Jets with 2-inch or 2½-inch nozzles supplying water under pressure of from 12 to 20 pounds by means of a centrifugal pump, seem preferable to small, high-pressure jets, although it is stated there is no appreciable difference in the efficiencies of the two systems.

Fig. 2 shows one form of mechanical agitator, or cutter, that is in general use for various soils, including sand. It has been found very efficient for all-round work. This particular one is an 84-inch cutter manufactured by the Norbom Engineering Company. Its object is to slice off portions of the material, which, falling between consecutive blades, are caught up by the suction and so removed. The shape and arrangement of the blades are not so important when working in sand, but they assume an immense importance when used in clay or other hard-packed material. The cutting edge is formed on the principle of a conical spiral, the section of the blades being designed to afford proper clearance in digging. The blades must be thick and heavily ribbed, for they are subject to enormous strains. They are bolted to a spider or hub, which imparts the rotary motion from the cutter shaft, and to a back or stiffening ring. The blades may be made of annealed cast steel, chrome steel or manganese steel, depending upon the degree of strength required.

In operation the cutter is revolved slowly while it is drawn into the bank by the swinging lines, the direction of rotation being from the bottom upwards, as regards the bank. This prevents any attempt on the part of the apparatus to climb up without doing useful work. Thus, when employed on radial cutting dredges, swinging from side to side on rear spuds, the cutter does its most effective work when making a swing in one direction, the return swing being made at a much greater speed and without much load. The swinging machinery should be designed to effect this without altering the engine speed to any great extent.

The speed of the swinging line may average 20 feet per minute when cutting, whereas twice this speed is desirable on the return swing, and it should sometimes be exceeded in order not to waste time. For dredges with 18 to 24-inch suctions, a line pull of 30,000 pounds is not too much to expect when working in packed material, and unless the ratio of gearing is properly determined on some such basis the revolutions of the engine will not be sufficient to develop the necessary power. An 8 by 10-inch double cylinder engine, geared 30 : 1 with respect to the winding drum, will give about 30,000 pounds line pull, with a 24-inch diameter drum, the engine turning up about 100 revolutions per minute. Greater engine speed would be preferable, but, as usually arranged,

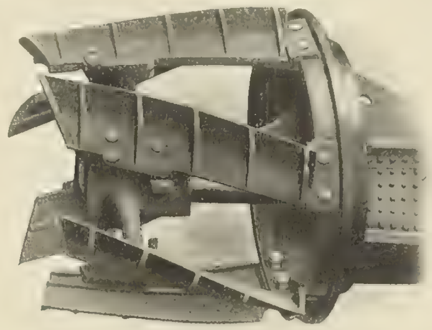


FIG. 2.—SUCTION HEAD

this is the best obtainable. On the light swing, however, the engine will speed up inordinately, unless the gearing be designed to limit it—say 50 percent more than when cutting.

A style of suction head in use by the United States Government Engineers on their work in dredging ocean bars is shown in Fig. 3. It is a sort of drag, fitted at the end of the suction pipe, one on each side of the vessel, provided with a scraper which tends to gather up the sand and force it into the mouthpiece. It is one of several that have proven themselves equally effective in one material or another, and is unique in that no agitator is applied beyond the scraping effect of the drag moving over the bottom at a speed of 4 or 5 knots. A very uneven bottom, or one where boulders are common, would tend to reduce greatly its efficiency. It seems to be admirably adapted, however, for work in exposed positions, where the soil is homogeneous and not too tenacious.

Many and varied, and indicative of great ingenuity, have been the devices proposed for the agitation of material to be dredged, and its introduction into the suction pipe. Thousands of dollars have been expended in testing them, the majority of which have not possessed sufficient merit to warrant their further use. Some have failed because they were too light and delicate to stand the severe service they were called upon to perform. Others failed owing to extreme weight and complexity of mechanism, that rendered them impracticable. Those that have survived are very few in number. In them the relative positions of cutter and suction mouthpiece have been carefully considered, as this is of equal importance to effective cutting alone. The solid material must be so directed that it will fall, or be projected, within reach of the suction. The influence of this suction rapidly diminishes as the distance from the end of pipe increases, and unless the slices of clay or masses of sand released by the cutter fall within the radius of this influence they might as well not have been cut at all. The force of the suction, or "suction head," varies with the velocity of flow maintained in the discharge pipe and indirectly with the depth of water. The difference in weight of a column of water and an equal column of the mixture, whatever its specific gravity may be, is a factor in the loss of "suction head," together with the shape of mouthpiece and the frictional resistance in the pipe. The last two items are nearly constant for any depth of water.

machinery to furnish the stuff. With 22 or 24-inch pipe and a good rotary blade cutter, working in sand, this limit is reached at about 2,000 feet of discharge pipe.

Clay, and soils in which clay forms a considerable part, such as loam, and some kinds of marl, often present more difficulties in their removal than any of the other soils. The

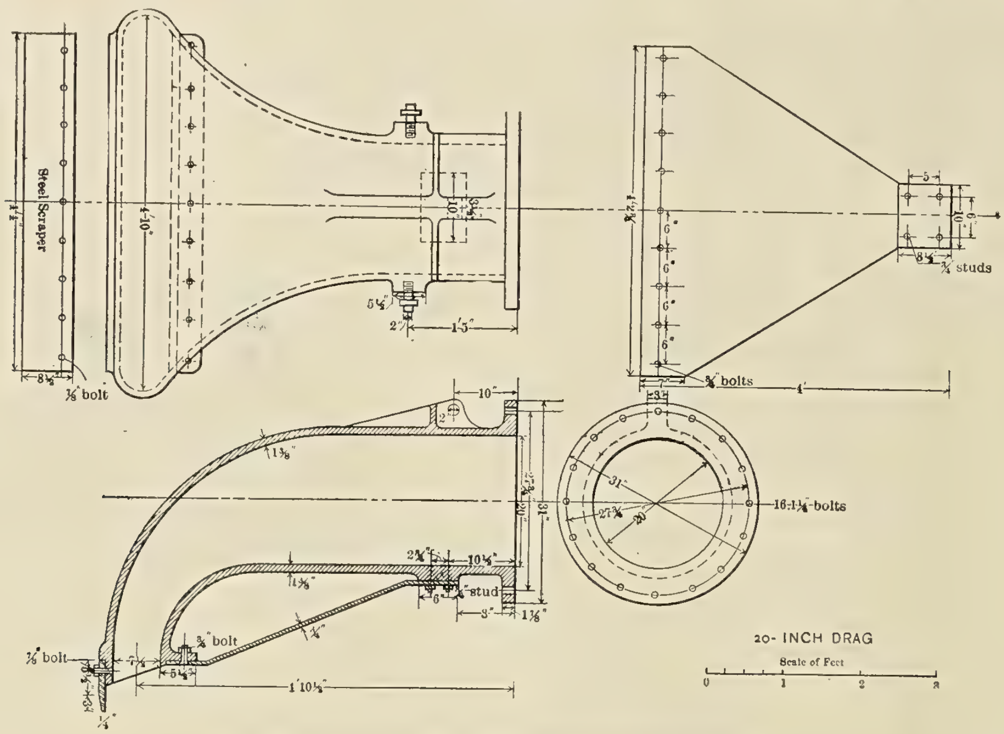


FIG. 3.—DRAG USED BY THE U. S. GOVERNMENT ENGINEERS

An unfortunate condition exists in this connection. Where the discharge pipe line is comparatively long, giving a high friction head, the velocity of flow is consequently reduced, which means a less powerful suction, and not so much material entering the pipe. So, in addition to consuming more power

FIG. 4.—POWERFUL DIPPER

in the pump, long pipe lines give a smaller percentage of solids in the output. Any good cutting apparatus can supply the material for long lines, or, in other words, the current of water flowing in the pipe is usually "saturated"; but on shorter lines, where the velocity of flow is higher, the output is often measured by the ability of the agitating or cutting

tenacious characteristic, which is the chief one, renders this soil not only exceedingly hard to loosen from its bed, but it interferes with the efficient working of the apparatus, no matter which method is in use. It tends to clog the blades of the cutter on a suction dredge, and with any of the bucket dredge types the material adheres so persistently to the sides when discharging that much time is frequently lost waiting for it to become dislodged, or in employing some outside means for dislodging it. Dredges of the ladder bucket, dipper, and hydraulic suction types have all been successfully worked in clay where correct designs were used. In deep water, where the others were not suitable, grab buckets have performed valuable service, although, generally speaking, they are not to be recommended for clay, especially if of a hard sort.

For moderately shallow water the dipper dredge is particularly adapted to the handling of the harder varieties, as a glance at the records of dredging operations on the Great Lakes will show. This type, though not originated in this country, is distinctly American, for it is generally employed here, while comparatively few are used in other countries. Foreign engineers have evidently not considered them of enough value to replace their ladder buckets, and perhaps the nature of their operations justifies this opinion. The magnitude or extent of much of the dredging carried on in Europe probably makes it inadvisable to employ an intermittent type of machine, such as the dipper and grab bucket, in spite of their simplicity, effectiveness and small cost. In the United States dredging contracts are more scattered, usually less extensive, more varied in character, and often in restricted localities calling for a machine adapted to varied conditions and less unwieldy, and also less expensive, than the ladder bucket type. The burden of first cost and high maintenance charges are more than the average contractor cares to assume.

Fig. 4 shows a dipper of large capacity, as manufactured by the Bucyrus Company. It is especially massive in construction, and following the principle they adopted years ago, made to do its work without breakdowns, no matter how severely it is treated. It is surprising to note the enormous penetrating power of one of these dippers when provided with teeth. In the larger sizes the line pull may reach 200,000 pounds, and as this is often concentrated on one or two teeth, not only its digging power is apparent, but also the necessity of giving abundant strength. The teeth are made of manganese steel, the rivet holes being accurately cored in the casting. The pressure is taken by shoulders on them, bearing on a reinforced plate edge, thus sparing the rivets to a large extent. In no other type of dredge can as great power be directed to one spot, so that it has come to be regarded as without a rival for digging the most resisting materials. The dipper dredge has its counterpart on land in the steam shovel, universally used for excavating. It is an extremely serviceable machine for digging at close range, where it is not required to reach very far below its own level. On the Panama Canal scores of steam shovels, of large and small capacity, have replaced the old French continuous-chain-bucket machines, and some of the credit for the successful completion of the canal will surely belong to them.

With many kinds of machinery the strength of the various parts may be closely estimated by engineers, but in the case of dredging and excavating machinery generally experience is the only reliable guide. Profiting by years of successful and unsuccessful designs, the manufacturers of this class of machinery have accumulated a vast amount of data that they use for the benefit of the public. I say "the public," for engineering work of this character is very often in connection with public improvements, and contract prices are much lower when reliable machinery can be obtained than when the contractors are confronted with the probability of breakdowns involving the loss of time and costly repairs. Still, viewed from another standpoint, the public have paid for the countless failures that make up this experience, and should reap the benefit. A larger margin of profit was demanded by those undertaking difficult or uncertain work, and naturally the people stood the burden. It is the exception nowadays, rather than the rule, for machinery of this class to fail when the conditions are fully understood by intelligent designers, and the amount of hard usage and unskilled handling that it will successfully withstand is truly remarkable.

Hydraulic suction dredges, when fitted with clay cutters, are profitably employed on such work. Failures have often resulted in trying to make suction dredges dig clay, when proper cutting mechanism was not provided. Such a course is hopeless. There have been cases where not more than 50 percent of the required yardage was made, due solely to unsuitable cutters. It is an all-important detail to which too much attention cannot be given. This inability of the suction dredge to cope with clay of the harder varieties for a long time confined its field of usefulness to sand and other light soils. This idea still prevails in some localities and among those who have not seen a well-designed clay cutter at work. Once clay has been dislodged, however, it is very easily transported, causing little added friction and slight wear, and a larger percentage can be carried in the pipe than is the case with sand. It also seems to require less velocity of flow to keep it in motion; where 8 feet per second will transport clay, 10 feet per second is better for sand.

Hardpan, a dense stratum of soil, usually underlying softer soil composed of clay or gravel, sometimes interspersed with boulders, is exceedingly difficult to work. What has been said of stiff clay applies likewise to hardpan, with a little emphasis laid on the desirability of great power in cutting or penetration. The suction dredge, however, having reached its limit of effective work in stiff clay, is not generally considered suitable for hardpan, and where boulders abound it should not be considered. The European ladder bucket dredge and the American dipper are accorded first place. Both can attack the resisting surface with directness and power, and if stones present themselves they, too, can be taken care of. Naturally, the buckets of the ladder type, with a maximum of 1 cubic yard capacity, are less able to handle large boulders than a dipper of perhaps 12 to 15 yards capacity, with a lifting power of 100 tons.

At depths beyond the limits of a dipper dredge, say 50 feet, the clamshell bucket armed with strong teeth, or the orange-peel bucket, may be quite effectively employed in hardpan, provided they have enough weight to give penetrating power. Not only is this weight necessary in allowing gravity to act and produce momentum in the descending bucket, but the scooping effect, when the leaves of the open bucket are drawn together, varies directly with the weight. This penetrating power is a fixed fraction or multiple of the weight for any one type and position of the scoops.

FIG. 5.—CLAM-SHELL BUCKET IN OPERATION

Fig. 5 illustrates a clamshell manufactured by the Hayward Company, of New York, in the act of closing through stiff material. If greater power were required, and the weight and construction of the bucket warranted it, the manufacturers provide another purchase by leading the flat link side chains over sheaves in the head, thus increasing the closing effect nearly 100 percent. There are several other methods of augmenting the penetrating power of the edges, such as enlarging the size of power wheel, thus giving greater leverage for the closing rope, and fitting multiple sheaves on upper and lower shafts, providing thereby as large a purchase as desirable. Buckets have been used where the opening and closing operations were performed by the positive action of compressed air, actuating a piston in a cylinder, wholly independent of the hoisting rope and the position of the bucket. The entire weight of this type is on the bottom while closing, there being no counteracting lifting effort, as with a closing rope. Another advantage claimed is the ability to close the bucket at any given depth, thus dressing off the bottom without excess excavation. An orange-peel bucket, such as shown in Fig. 6, has many advantages over the clamshell in hard digging, particularly where boulders or broken rock have to be handled, as the penetrating effect of the pointed leaves is obviously greater and the three blades either force the material inside the bowl or grasp any stones or other hard objects in their firm grip. Large power wheels assure ample strength in this grip. Another illustration gives a splendid idea of the manner in which a four-bladed bucket is capable of holding and lifting fragments of broken rock.

When gravel is encountered, composed of small, smooth pieces of hard rock, usually mixed with coarse sand, it is not a difficult problem for the contractor. Unless it has become very compact, any type of dredge will remove it. Hydraulic dredges, although not generally considered ideal for this class of material, have often been successfully employed on it. The wear on the inside surfaces of the pipe is considerable, and the noise coming from the interior, while gravel or shells are being transported, is like the rattle of musketry, but the work is accomplished.

The ladder bucket type is most efficient in this kind of dredging, combining continuity of action with large volume and very little loss of power, except that due to raising the material to a height sufficient to allow sliding into scows and the loss by friction, which is at all times a large item.

The removal of rock usually calls for special apparatus. When solid rock is encountered, fortunately not a common occurrence in dredging, it is necessary to resort to blasting or hammering. The latter method consists in breaking the rock into small fragments by the repeated blows of a heavy weight falling a considerable distance, or by the hammering action of drills under a steam or air piston. Messrs. Lobnitz & Co., of Renfrew, have developed an efficient rock-breaking machine, employing the first system. A steel ram, fitted with a renewable point, conical in shape, made of hardened steel, the whole welghing in the neighborhood of 20 tons, is allowed to drop on the rock bottom repeatedly until the desired depth of penetration is reached. This series of blows is delivered at points about 3 feet apart, pulverizing a portion and breaking up the rest into fragments of a size that may be easily removed by dredging, using a style of bucket most suitable for the particular conditions.

Fig. 6.—Orange-Peel Bucket

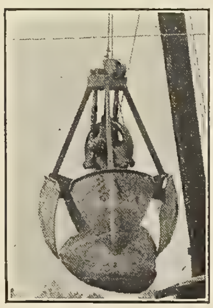


Fig. 7.—Handling Rock

Much of the sub-aqueous rock found is in a disintegrated state, due to mechanical and chemical action, and may be attacked at once by the dredging machines. As with hardpan, the ladder bucket and dipper dredges are most frequently employed. The buckets of the former type are run at as great a speed as possible, and, striking the soft rock with considerable energy, their steel teeth penetrate the material and bring fair-sized pieces to the surface. Of course, for this service the machine must be strongly built and be provided with ample engine power, for it is only a question of strength in the apparatus and of steam to overcome resistance. Advantage is taken of the weight of the buckets, as well as the tension in the chain, to accomplish this result. It is obvious that a ladder bucket dredge cannot be employed where the water is rough, as the waves would cause violent shocks to the ladder on account of its rigid construction. In rock dredging this limitation is especially imperative. In practice a wave height of more than two feet is considered dangerous. Stone grapples, ranging in capacity from 1 to 10 cubic yards, render good service for lifting rocks, as well as for ripping cribwork and pulling up stumps.

As indicated throughout this article, there are no clearly defined limits for any one type of dredge, all being suitable in many cases. Furthermore, even if one has an advantage over the others for a given piece of work, it is often impossible to employ it, as they are very expensive machines and one may not be available. So necessity has frequently forced the adoption of a type for operations a little out of its line, and the resourcefulness of the contractor has been taxed to find a way of using it economically. It is seldom that some method has not been devised to solve the problem, a tribute to fertile brains and the application of wide experience.

Dutch Suction Dredger

BY F. MULLER VAN BRAKEL

Though most dredgers are built with the sole purpose of removing material, some are constructed with the contrary purpose of collecting material—i. e., when the material has value in itself, as is the case with gold, tin, shells or gravel. Several of these dredgers are working on the rivers and on the coasts of Holland, bucket-gravel dredgers being used on the rivers Rhine and Waal, while suction dredgers are working on the northern coast dredging shells or gravel.

The latest gravel dredger was launched March 10, 1913, from the yard of Messrs. E. J. Smit & Son, Hoogezand, Holland. The vessel, which is being built to the order of Messrs. G. Doeksen & Sons, of Terschelling, had to meet the requirements of an efficient gravel dredger and also of a first-class seagoing tug.

The principal dimensions are:

Length over all	116 feet
Length between perpendiculars	105 feet 6 inches
Beam molded	18 feet 9 inches
Depth	10 feet
Block coefficient	0.507
Coefficient of load line	0.79
Coefficient of immersed midship section	0.793
Bunker capacity	60 tons
Forward trim tank	9 tons
Aft trim tank *	17 tons

The hull is built of mild steel to German Lloyd's highest coasting class, under special survey, with reinforcements in the bow for working in ice. Seven bulkheads divide the hull into eight compartments, i. e.: (1) Forward trim tank with chain locker; (2) officers' quarters, consisting of saloon and separate cabins for master and chief engineers; (3) boiler room with side bunkers; (4) cross bunker; (5) pump room; (6) engine room; (7) crew quarters; (8) trim tank.

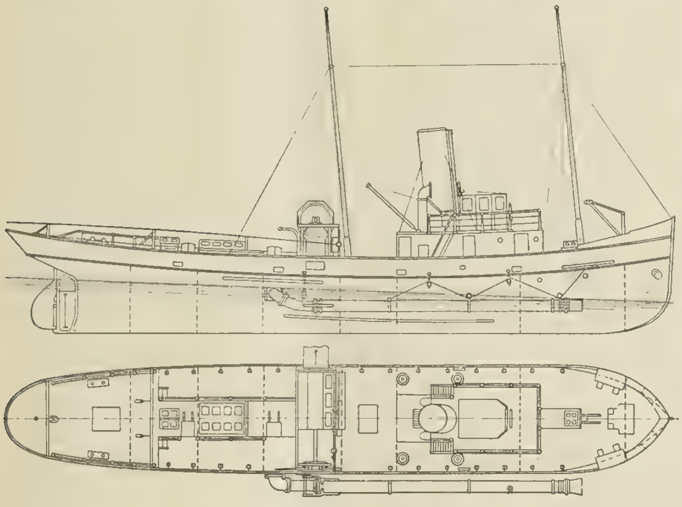
The body plan shows rather fine lines for the underwater body, especially aft, allowing an easy flow of water towards the propeller, and promising, in connection with the small beam, the best possible speed under given conditions. As the heavy revolving sieve, with steam engine, covers, chutes, etc., is placed rather high (about 12 feet above deck) a great initial stability is desirable. The load-line area was therefore designed as large as consistent with the limited beam. This produced another valuable property—i. e., strongly flaring out frames in the bow which will keep the propeller well under water when pitching in a heavy sea. Bilge keels are fitted to reduce the rolling movements.

Steam for all purposes is furnished at 200 pounds per square inch by a Scotch boiler of 1,200 square feet heating surface,

* Both trim tanks may be used as fresh-water tanks for boiler feeding.

having two Morison furnaces. The main engine is a triple expansion engine, surface condensing with Hackworth valve motion, capable of developing 340 indicated horsepower. By heavy clutches it may be coupled either to the gravel pump shaft forward or to the screw shafting aft. When the ship is to be used as a tug the screw shafting with clutches is replaced by a set of shafts with fixed flange couplings. Air, feed and bilge pumps are driven from the low-pressure crosshead.

The auxiliaries are installed in the engine room and pump room, and include a surface feed heater between the feed pumps and boiler, a feed-water filter between the hot well and feed pumps, a Thwaites centrifugal circulating pump direct connected to a steam engine (in addition to the condenser connection this pump is piped to the deck for salvage purposes and to the bilges), and a duplex Worthington steam pump with suction pipe lines to trim tanks, bilge suctions of all compartments except pump room, hot well and sea, and



DUTCH DREDGE VOLHARDING

with discharge piping to trim tanks, boiler check valves, deck service, condenser, stuffing box of gravel pump and to sea. There is also a Worthington duplex steam pump to keep water pressure on the stuffing box of the gravel pump. This pump may be connected to deck service, the after tank and the condenser. An ejector is supplied for emptying and filling the after trim tank in much shorter time than a steam pump is able to do. This may be necessary when the boat is to pass the shoals on the coast during bad weather. As soon as the shoals are cleared the after trim tank has to be filled again to keep the screws well under water. On deck are placed a powerful steam windlass for handling the anchors and suction tube, and a small compound steam engine for revolving the gravel sieve.

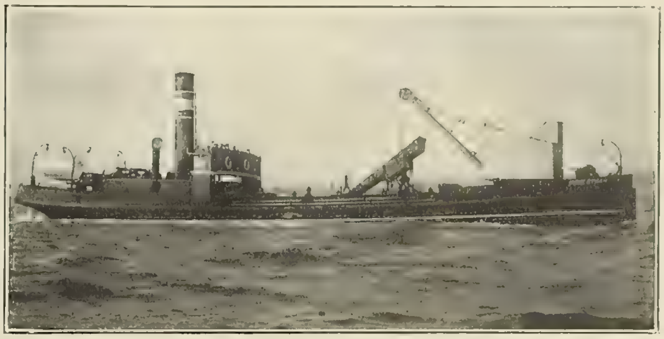
The 66-foot suction tube is carried on the starboard side and is connected to the inboard suction pipe by a rubber hose with steel spring strengthenings.

The gravel pump is of special design, invented by Mr. D. Doeksen. It is constructed of mild steel with cast steel reinforcements and heavy linings, of which a double set is supplied. By taking away one shaft between the crank shaft and impeller shaft, the pump can be opened by moving backward the whole of the front cover, the impeller with shaft and bearing, sliding along a pair of cast iron rails, thus laying open the impeller and pump for inspection or relining. The gravel pump discharges into a "shedding" box placed about 12 feet above deck, from which the material passes through a revolving sieve and is delivered to chutes on the port and starboard.

Earlier gravel dredgers deliver the finer and coarser gravel on the same side of the vessel, and therefore require one or two rubber conveyor belts to bring the two kinds of material to different sides of the ship. In this dredger the sieve and chutes are arranged in a way which delivers the coarse gravel on the starboard and the finer material on the port side without the use of conveyors, thus doing away with an expensive and troublesome apparatus.

Dredger Priestman

Until recently trouble has been experienced in securing an efficient dredge capable of meeting the demands for harbor work in Newfoundland. Not long ago the dredger *Priestman*, built by Smith's Dock Company, Middlesbrough, steamed out under her own steam from Milford Haven to St. John, where



DREDGER FOR HARBOR WORK IN NEWFOUNDLAND

she proved satisfactory in every respect for the work for which she was intended, and she was accepted by the Newfoundland Government. The *Priestman* is 127 feet 3 inches long, 26 feet 6 inches beam, 11 feet 3 inches depth, with a draft of 10 feet. The vessel has a speed of 8½ knots and, as can be seen from the illustration, one grab dredger is provided giving the dredge an output of upwards of 110 tons per hour. The capacity of the hopper is 325 tons.

Grab Dredger North Western

Messrs. Ferguson Bros., of Port Glasgow, recently supplied to the London & Northwestern Railway Company, for work-

GRAB DREDGER BUILT FOR THE LONDON & NORTHWESTERN RAILWAY

ing at the Gaston Docks, a self-propelling hopper dredge with a capacity of 1,000 tons and equipped with four grab dredges, capable of giving the dredge an output of 600 tons per hour. The dredge is 195 feet long, 26 feet beam and 16 feet depth.

Two 15-Yard Dipper Dredges for Panama

In order to open portions of the channel of Gatun Lake, to dredge the canal proper, and to pick up the slides that are bound to be slipping into Culebra Cut for some time to come, the Isthmian Canal Commission have recently ordered of the Bucyrus Company, South Milwaukee, Wis., the two largest dipper dredges that have ever been built. These dredges are duplicates and follow very closely in design the Bucyrus dipper dredge *Toledo,* owned by George H. Breyman & Brothers, at work in Boston harbor. This dredge was very thoroughly described in the 1912 dredge number of INTERNATIONAL MARINE ENGINEERING. The advance in high-powered dredge construction, based upon the operation of the *Toledo,* which is the largest dredge of this type ever constructed, and the adaptation of the design of the *Toledo* to the conditions to be encountered at Panama should prove of more than ordinary interest to engineers.

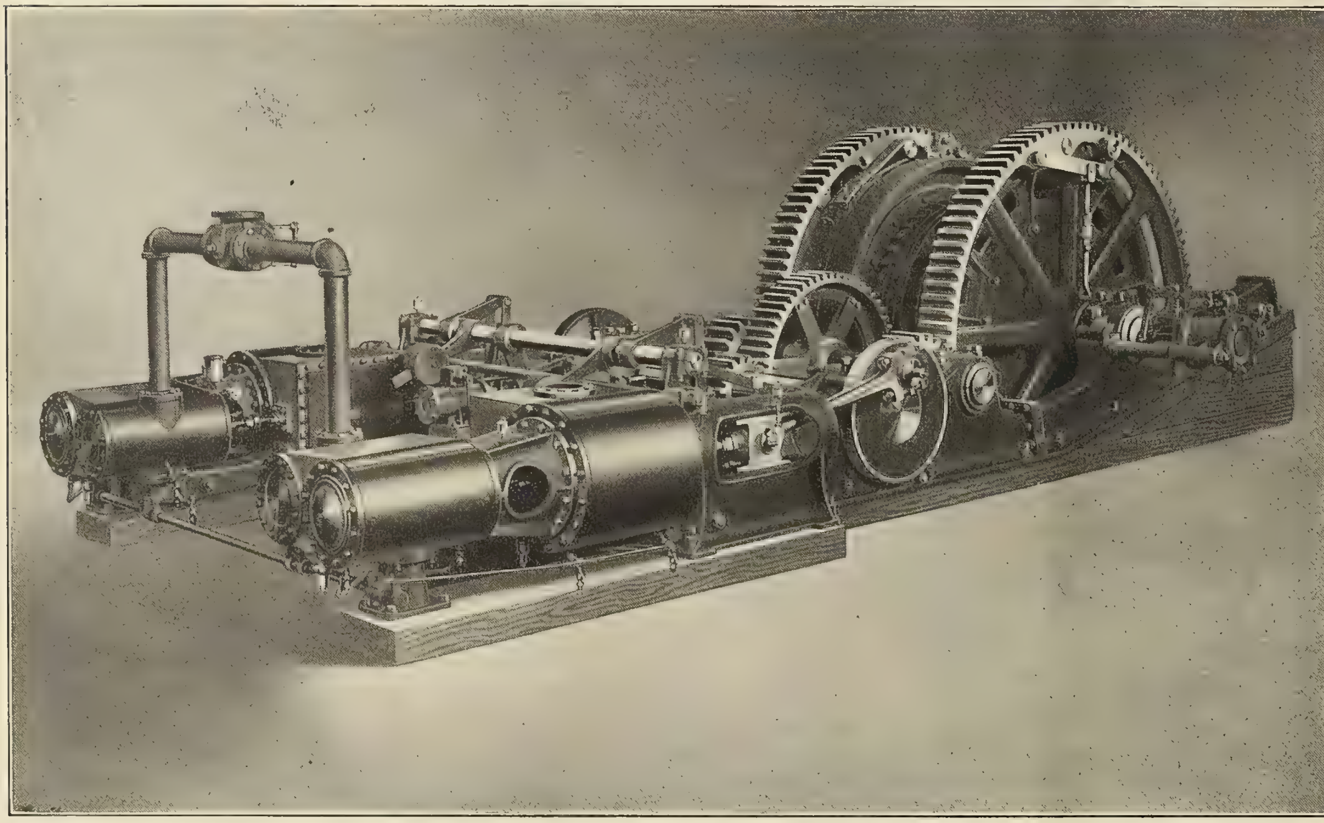


FIG. 1.—HOISTING ENGINE AND DRUM

The greatest difference between the two designs is to be found in the steel hulls with which the new dredges will be equipped. This, of course, makes a far stiffer and stronger dredge than a wooden hull could possibly do.

The dredges will dig to a depth of 50 feet below the surface of the water, and are of the single part wire rope type. Their hulls are to be 144 feet long by 44 feet in width, 16 feet 6 inches deep at the bow and 13 feet 6 inches at the stern.

The main engines illustrated in Figs. 1 and 2 are horizontal twin tandem compound condensing, with cylinders 16 inches and 28 inches in diameter by 24-inch stroke. The valves, which are operated by the Stephenson link motion, are of the piston type on the high-pressure cylinders and flat slide double-ported balanced type on the low-pressure cylinders. As may be seen in Fig. 1, the engines are compound geared to large spur gears on either end of the hoisting shaft which carries the drum. This is cast steel of the differential type and is grooved for 3¼-inch wire rope. This shape gives the maximum digging power and the slowest speed at the time when the dipper is digging, and the angle between the hoisting rope and dipper handle is sharpest. As the dipper emerges from the material the rope reaches the larger diameter of the drum, thus gradually increasing the speed at the expense of the power when this is most desirable. In these dredges the small diameter of the drum has been increased over that of the *Toledo* with the view of lengthening the life of the rope. This, of course, has necessitated changes in gear ratio over the older dredge. The drum is mounted loose on a forged steel hoisting shaft, the power is applied through two outside wood-lined band frictions, one on each side of the drum of special design. These frictions are operated by a steam-actuated thrust cylinder shown in Fig. 2. The device has proved very successful —indeed, it seems to be the only type which will take care of the enormous power of the engines.

The swinging machinery is operated by an independent single expansion double engine of the link reverse type, having cylinders 12 inches in diameter by 16-inch stroke. It drives a cast steel cylindrical swinging drum which carries two swinging ropes leading to the circle.

The swinging circle is of structural steel 24 feet in diameter, similar to the *Toledo's,* which is shown in Fig. 3. The dipper is hauled back by means of an independent, horizontal, double-cylinder, single expansion engine geared directly to a cylindrical drum.

The spud machinery is a departure from the *Toledo* design. On the Panama dredges the hoisting and lowering of the forward spuds is to be through four-part hoists. The engines are to be connected directly to the drums by friction clutches, so that they may be readily disconnected for lowering. On the *Toledo,* as on other dipper dredges, the spuds were driven through a two-part hoist and the drums were driven by jaw instead of friction clutches. In the past the practice has been to place the spuds on the corners, which limits the swing of the boom to 120 degrees. Lately there has been a demand for a swing of 180 degrees. So, in order to take care of this on the new dredges, the spuds have been moved back from the corners. Furthermore, it has been found desirable to exert the full power of the engines with the boom swung to the limit. With the old arrangement this was impossible, hence a radical departure was necessary.

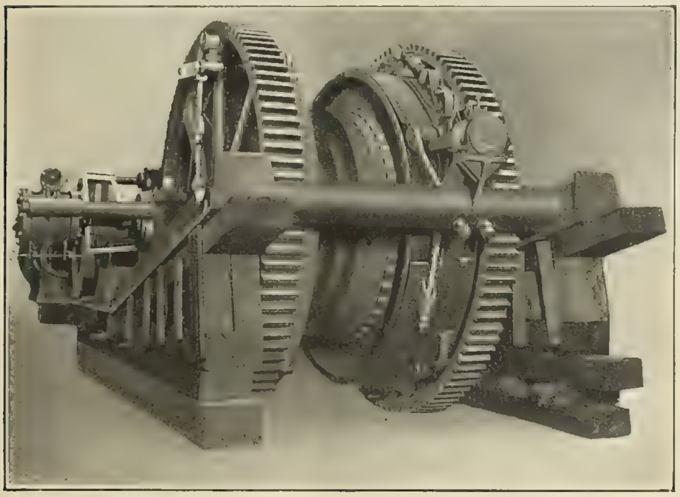


FIG. 2.—HOISTING DRUM, SHOWING THRUST CYLINDERS WHICH OPERATE THE FRICTION AND BRAKE BANDS

The stern spud machinery has also been considerably changed. In the past the common, though not the invariable, practice has been to operate the spud by means of a wire rope attached to the foot of the spud. This type is in very general use on the Great Lakes, and has been found very satisfactory for depths not exceeding 30 feet. Where the digging runs 50 feet deep the increased weight caused by the length and size of the spud often causes the operator to allow it to fall too fast when lowering. The tremendous momentum thus developed is apt to tear out the fastenings when it is attempted to break the fall. This naturally causes considerable delay, as it is generally necessary to employ a diver to do the repairing. On the new dredges, therefore, the stern spud, which is of the trailing type, is hoisted and lowered by a rack and pinion drive. All three spuds are of steel construction. The forward spuds are 48 inches square and 72 feet long and the stern spud 30 inches square and 80 feet long. The spud feet are collapsible, so as to facilitate raising.

The boom is to be 62 feet long, built of steel of the solid plate girder type. The boom sheaves are heavier and larger than ever before used. The dipper handle is of the usual construction, built up of Oregon fir reinforced with heavy bars and plates. It is 72 feet in length. The racks are of Bucyrus nickel chrome steel, heavily shrouded.

The dredges are to be supplied with two dippers, one of 15 cubic yards and one other of 10 cubic yards capacity. The latter is extra heavy for rock work and is equipped with teeth. The dippers are to be tripped by a steam cylinder mounted on the boom.

For moving scows two three-drum winches are supplied. These are located on the main deck, one on each side of the house. The engines, which are inside the house, are each a 6-inch by 6-inch horizontal type engine.

The steam plant on each dredge is very complete. Two Scotch marine boilers provide the steam; each boiler is to have two Morison suspension furnaces. A condenser with an air pump and a centrifugal circulating pump driven by an independent engine is supplied, and there is a closed feed water heater, feed pumps, two fresh-water tanks built into the stern and a complete electric light plant. Both dredges are to burn either coal or oil, so two large oil storage tanks are provided as well as coal bunkers.

The dredge is built especially with a view to rapidity of work and convenience in operation. Wherever any force is required to operate a lever, the lever in the stand simply operates the valves of the steam cylinder which is connected with the lever mechanism. Thus these big dredges are easier to operate as a one-yard dredge. The entire dredge is operated by four men—the dredge runner, the cranesman, one fireman who operates the stern spud, and the man in charge of the scow winches.

FIG. 3.—A VIEW OF THE SWINGING CIRCLE, BOOM, SLIPPER SHAFT AND DIPPER HANDLE

The output of the dredge should vary between 500 and 600 cubic yards an hour when working fairly steadily. The *Toledo* has often made 9,000 cubic yards of hard sand in fifteen hours. Delays of various sorts would, in the natural course of events, frequently cut this down to an average of between 3,000 and 4,000 cubic yards a day.

The dredges are both to be erected at Newburg on the Hudson, and the preliminary test is to be made there. They will then be towed to Panama, where the final test will be held.

New Hydraulic Dredge Niagara

The Duluth-Superior Dredging Company, of Duluth, Minn., are having built a 20-inch hydraulic dredge which may safely be said to be the heaviest and most powerful of its size ever constructed. It is particularly interesting, as it marks another stride in the hydraulic dredge design into the field which has heretofore been held by the dipper and elevator dredge.

This dredge, named the *Niagara,* will be used on the Saginaw River, where this company has a large Government contract. Last year this company operated their hydraulic dredge *Enterprise* on the same project, but found it advisable to use two plants the coming season.

The *Niagara* is just receiving the finishing touches at the yard of the Manitowoc Shipbuilding & Dry Dock Company, Manitowoc, Wis., the company which designed and built the hull. The machinery was supplied by the Bucyrus Company, of South Milwaukee, Wis.

The hull is 135 feet long, 43 feet wide and 11 feet deep. Two watertight longitudinal bulkheads run continuously from end to end and there are also three watertight athwartship bulkheads. The coal bunkers are in the side compartments below the deck abreast of the boilers, and there are also two bunkers alongside the single boiler.

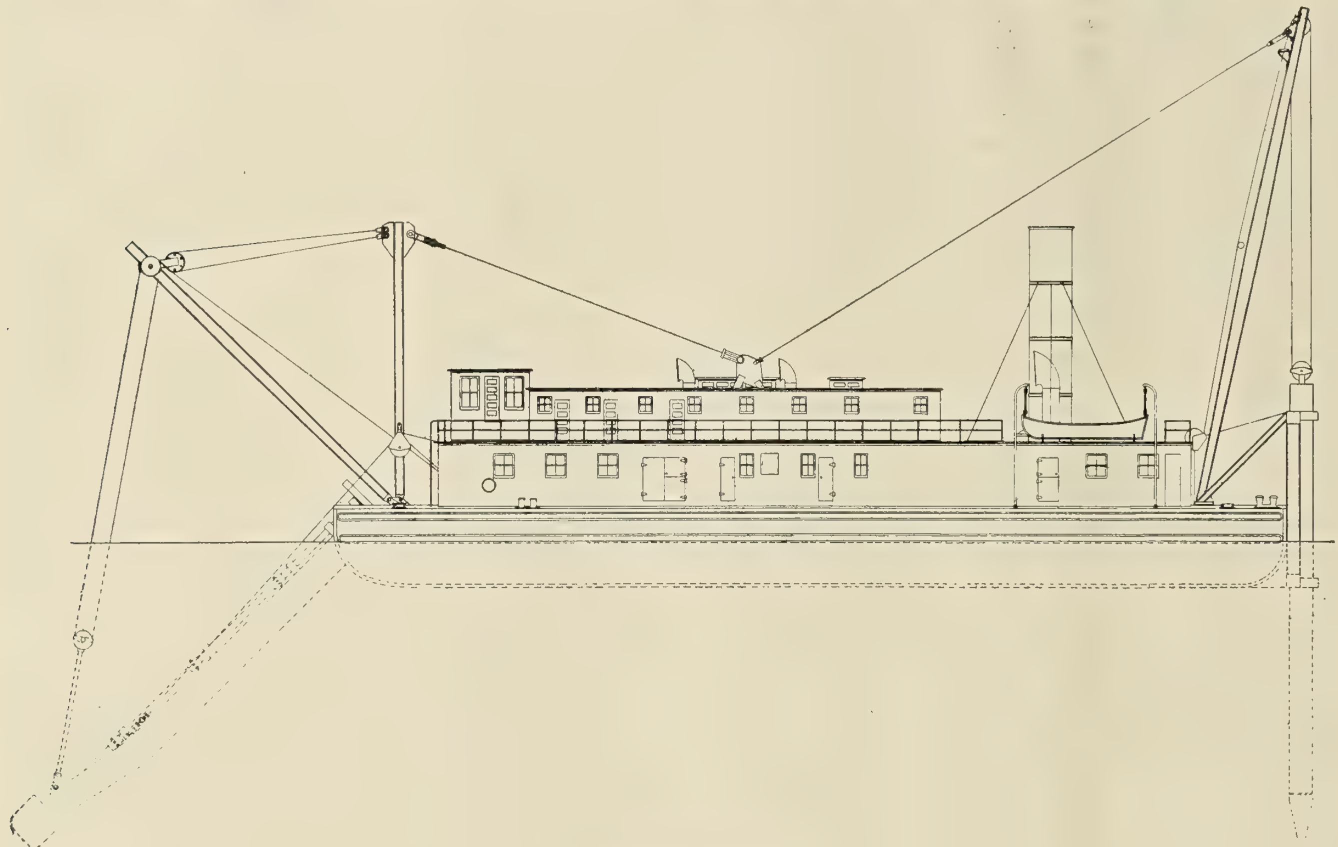


FIG. 1.—OUTBOARD PROFILE

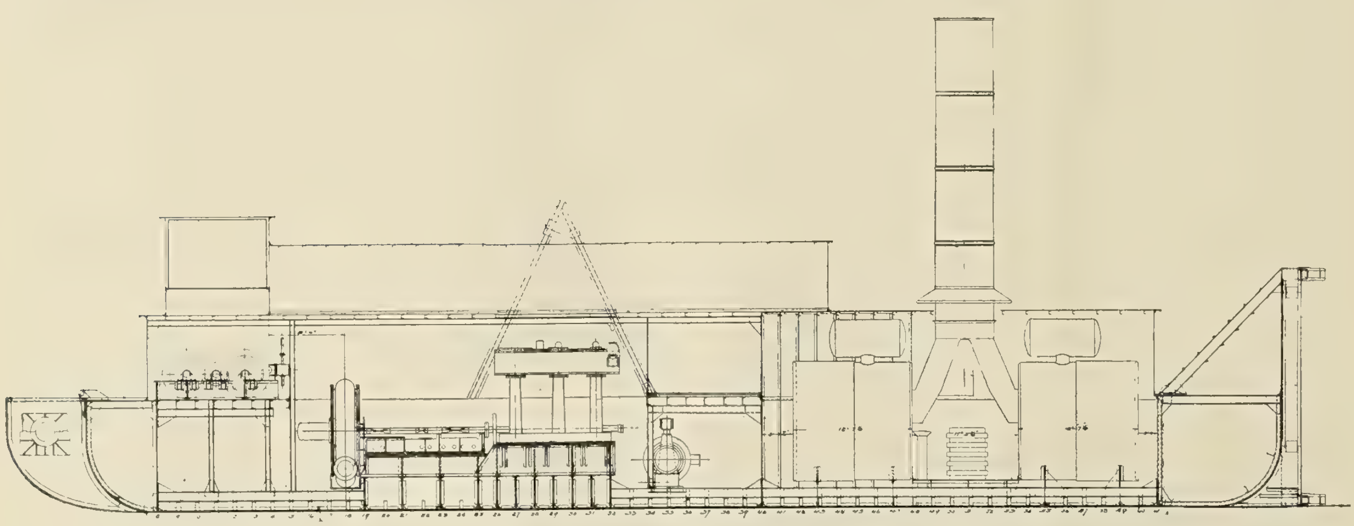


FIG. 2.—INBOARD PROFILE (ENLARGED)

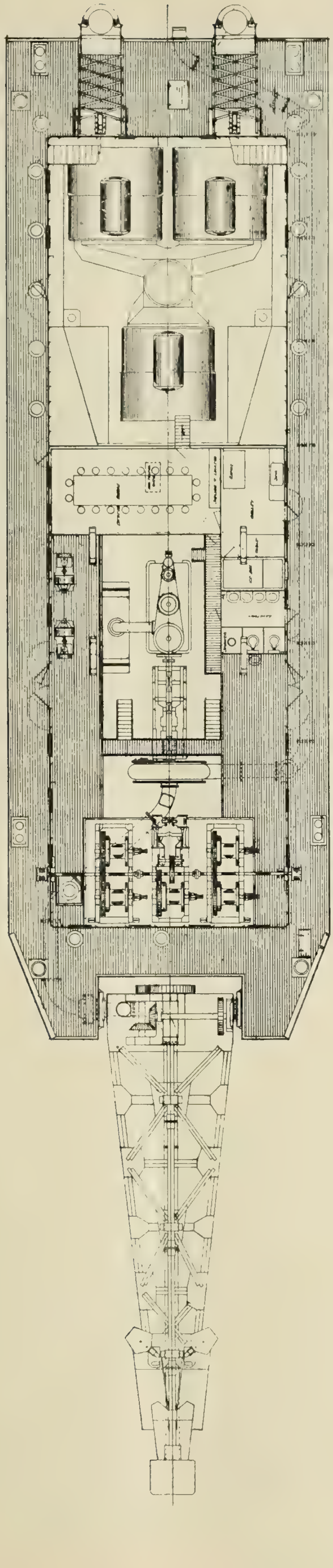


FIG. 3.—MAIN DECK, SHOWING ARRANGEMENT OF MACHINERY

The engine and pump are placed on a massive foundation built on a series of high floors, extending across the hull, to minimize vibration. The ladder well at the forward end is thoroughly braced and the shell plate is ⅝-inch thick in this vicinity. There are two wale strakes on each side of the hull formed of corrugated plate packed with oak. The deck is covered in all the exposed places with 4-inch by 4-inch fir decking, bolted to the deck plate and calked.

The pump is driven by a 1,000 horsepower triple expansion vertical marine type engine, built by the Marine Iron Works of Chicago, Ill. This engine develops a speed of 200 revolutions per minute and has enough power to pump the material through a 5,000-foot pipe elevated to a height of 10 feet above the water. The dredge is designed for digging unusually hard material; the pump, therefore, is of extra heavy construction throughout, in order to take care of the unusual wear and of the very high water pressure. Exclusive of the engine it weighs 71,000 pounds; the runner is 100 inches in diameter. Both these parts, together with the pump heads and the cutter

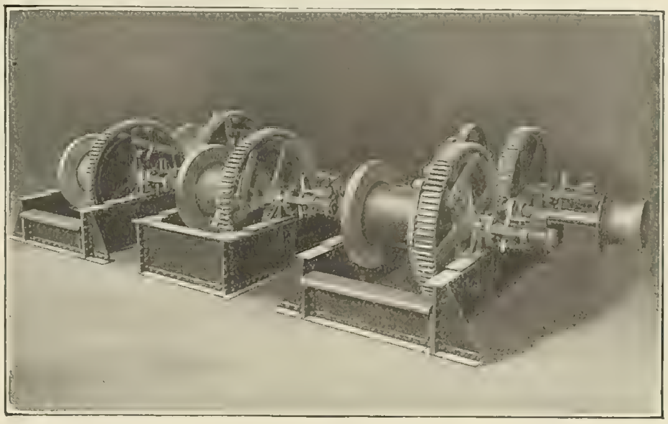


FIG. 4.—FIVE-DRUM WINCH

head, are of the special Bucyrus nickel chrome steel, which has given such splendid results in the unusual heavy wear imposed upon it in placer dredges. The casing, in accordance with the modern method, is unlined.

The cutter-drive machinery is undoubtedly the heaviest and strongest ever before used on this size dredge. The engine is double cylinder, 12 inches by 15 inches, of extra heavy construction throughout in order to enable it to run at a full boiler pressure of 200 pounds per square inch. The gearing is of extremely large and heavy design, with the teeth cut from the solid. The cutter shaft is 10 inches in diameter on the upper end and increased at the lower end, where it fits the cutter head to 11½ inches in diameter. Another unusual feature indicating the tremendous strength of the machine is the fact that the gearing on the top of the ladder is mounted on a single cast steel bed plate, which, it is claimed, absolutely insures rigidity under the most trying conditions.

The weight of the cutter drive machine is about 52,000 pounds. The cutter head is also a very unusual design. It is of the six-bladed type, made of nickel chrome steel. The blades, however, are equipped with teeth fitted into sockets, whose function is to disintegrate the hard material it doubtless will encounter. These teeth are arranged so as to alternate, three on one blade and four on the next.

The suction ladder is of the plate girder type, extra heavy, weighing 77,000 pounds exclusive of the machinery. The spuds are 39½ inches outside diameter and 67 feet in length. They are built of lap-welded steel pipe ¾-inch thick and are fitted with cast steel spud points.

The winch is of the usual five-drum type illustrated in Fig. 4, and the rest of the fittings, the A-frame gantry, etc., are all exceptionally heavy, to conform with the rest of the design.

The boilers, of which there are three, are 12 feet 6 inches diameter by 12 feet long, each with two 48-inch Morison corrugated furnaces and a 48-inch by 8-foot steam drum. The boilers were built for a working pressure of 200 pounds and were furnished by the Manitowoc Boiler Works Company.

The engine room equipment consists of a surface condenser with an independent pump 10 inches by 16 inches by 18 inches, an 8-inch Wheeler volute pump direct connected to an 8-inch by 8-inch Sturtevant engine, two 8-inch by 5-inch by 12-inch Dean Bros. boiler feed pumps, two 7-inch by 4½-inch by 10-inch Dean Bros. general service pumps, one 4-inch by 4-inch by 5-inch Burnham sanitary pump and an American Steam Gauge Company 4-inch grease extractor. The electric lighting equipment consists of two 10-kilowatt Allis-Chalmers generators, direct connected to A. B. C. engines. Trolleys over the main engine and the pump facilitate the overhauling of the cylinders and pump runner.

A two-story deck house covers the machinery and boilers and is built entirely of steel. The lower house contains the kitchen, with a large icebox, the dining room and the crew's wash room. The upper house is devoted to sleeping rooms for thirty-six men; also the officers' wash room and bath. The quarters throughout are ceiled in varnished yellow pine and have maple floors, and all the rooms are heated by steam.

The dredge is lighted throughout by 140 electric lights, and a search light is installed on the roof of the operating room. This operating room is in an elevated position forward of the upper house, and the provision of many large windows gives the operator an unobstructed view of the work.

The Bucyrus Company has done much in developing the hydraulic dredge to the point which it has now reached. A few years ago one would never have dreamed it possible that a hydraulic dredge could dig anything but sand, loam and the softest clays. In the construction of the barge canal in New York State, however, it was necessary to develop a type of dredge that could dispose of material at some distance from the digging point and at the same time be able to handle unexpected streaks of cemented gravel, boulders and other hard material. This is what led to the design of the 20-inch Bucyrus hydraulic dredge, which has made such a splendid name for itself. The Duluth-Superior machine is the latest development of this type, and for this reason it should prove of unusual interest to the engineering world.

Tyne Improvement Dredger

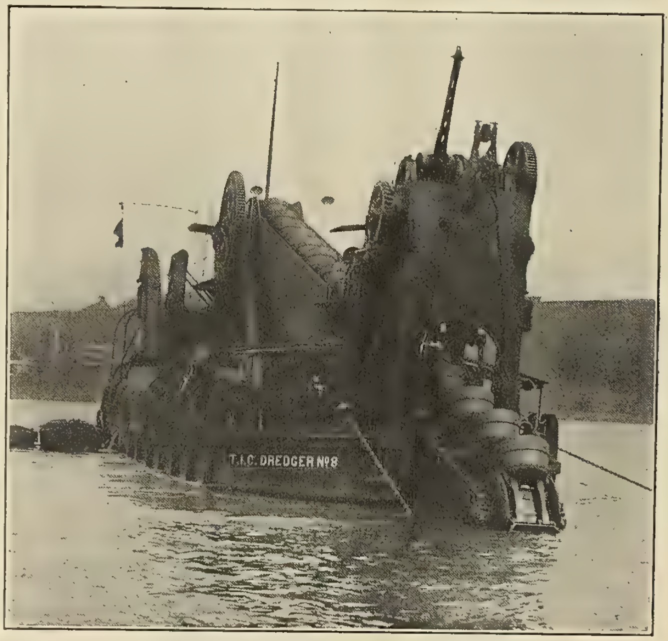
BY F. C. COLEMAN

The illustration shows a bucket dredger which has been built by Messrs. Fleming & Ferguson, Ltd., to the requirements of the Tyne Improvement Commission and under the direction of Mr. N. G. Gedye, M. Inst. C. E., the Commissioners' chief engineer. The dredger, in addition to being suitable for dredging close up to quay walls, is non-propelling, of the bow-well, bucket-ladder, barge-loading type, and her dimensions are as follows: Length, overall, 147 feet; breadth, molded, 30 feet; depth, molded, 12 feet. She is capable of raising 600 tons of material per hour from a depth of 45 feet, and of dredging to a depth of 35 feet close up to quay walls. Side shoots are arranged for discharging the dredged material over either side into hopper barges, the shoots being raised and lowered by an independent steam engine.

The vessel is built of Siemens-Martin mild steel plates and angles in excess of Lloyd's 100 A. I. class and under their special survey. The hull is subdivided into twelve watertight compartments by means of steel bulkheads, all carried up to the main deck. The accommodation for the officers and men is conveniently arranged and fitted with all necessary requirements for the comfort of the crew. Heavy beltings and strong vertical fenders are fitted along the sides of the vessel to take up the wear and shock of hopper barges when approaching and lying alongside the dredger in heavy weather.

The engines for working the bucket gear are of the vertical compound surface condensing marine type with steam reversing gear, etc. The gearing between the engine and tumbler shaft is of cast steel, with machine-cut teeth, and arranged to give four speeds at which the buckets can be worked to suit the varying nature of the materials to be dredged. The chain of buckets and links are of strong design and heavy construction for working in rock or boulder clay.

The bucket ladder, of Siemen's steel, is built of heavy scantlings in accordance with the builders' latest improved design, the riveting throughout being done by hydraulic machines.



DREDGER MOORED FOR OPERATION

The lower tumbler and the rollers on the top of the ladder for guiding the buckets are fitted with the builders' patent lubricated bearings, which exclude the sand and water from the bearing surface. Three of the builders' special mooring winches are fitted for manipulating the mooring chains while the vessel is at work, all the barrels being worked independently by means of patent friction clutches.

The hoisting machinery for lifting the bucket ladder is fixed on the fore framing and drives direct the large grooved barrel on to which the wire ropes are wound. Special provision is made, so that, should the main ropes break and the ladder fall to the bottom, the preventer ropes which are led up the ladder can be coupled direct to the barrel and the ladder raised without loss of time. A 5-ton crane is fitted on deck for overhauling the buckets, etc.

Steam at 160 pounds pressure for operating the dredger is supplied by a single multitubular marine boiler. A very complete installation of electric light is fitted for night working, the lamps being of the metallic filament type. The dredging craft belonging to the Tyne Improvement Commissioners now consists of 5 dredgers, 14 steam hoppers, 20 dummy hoppers and 5 steam tugs, and as affording some illustration of the improvement which has been effected in the waterway it may be mentioned that during the period from 1850 to Dec. 31, 1911, no less a quantity than 128,566.360 tons of material were dredged by the Commissioners from the river and taken to sea, and that during each of the twelve years from 1900 to Dec. 31, 1911, an average quantity of 2,002,407 tons were dredged from the river and taken to sea.

Performance of Ellicott Dredge Wahalak

No more striking example in the evolution of machinery can be found than the efficiency of present-day pipe line dredges over the dredges of twenty years ago.

In 1893 the United States Government entered into contract for dredging in Charlotte harbor, Florida, at a price of 74.4 cents (3s. 1.2d.) per cubic yard for scow measurement, equivalent to about 60 cents (2s. 6d.) measured in place. Contracts varying from 20 to 60 cents (10d. to 2s. 6d.) have been made from time to time for dredging in the different harbors on the Atlantic, Gulf and Pacific coasts. That the contracts paid well is proven by the existence of many wealthy dredging companies which have made Government work a specialty.

Of this there can be no doubt, but in former years contractors were limited in their profits by the inadequate machinery then in use.

The contract for work in Charlotte harbor, Florida, referred to was annulled and a plant rented at $333.33 (£68.5) per day. This plant worked thirty-five days at a cost of $12,666.51 (£2,600) and removed only 36,982.5 cubic yards, making the cost 34½ cents (1s. 5.25d.) per cubic yard, removing only an average of 122.46 cubic yards per hour. The work accomplished and cost per cubic yard of the work of the dredge *Wahalak*, built by the Ellicott Machine Corporation, Baltimore, Md., for the United States in 1910, presents a startling contrast. For twelve months, working in Mobile harbor, Alabama, this dredge made an hourly average of 574.9 cubic yards at a gross cost per cubic yard of 3.24 cents (1.625d.)—a cost of 31.26 cents (1s. 3.625d.) less per cubic yard than that of the dredge in Charlotte harbor. This shows the effect of the evolution in dredging machinery.

The dredge *Wahalak* is but one of a type of a large number of successful dredges built by this firm for the United States Government, as well as for private corporations in this and other countries. Much of the machinery was originated by the Ellicott Machine Corporation as a result of many years of study and experience. This dredge is of the following dimensions: Length overall, 150 feet; width, 40 feet; depth, 11 feet 6 inches. The hull is built of steel throughout and is divided into four watertight compartments by means of transverse bulkheads, and is stiffened by two fore and aft bulkheads.

The superstructure is of wood and consists of a house over the main deck, which covers all machinery. The living quarters, etc., are placed above the main house and consist of pilot house, in which is placed the operating appliances; aft of the pilot house are the officers' quarters, galley, mess room, etc. All windows are screened, thus minimizing danger from malaria-infected mosquitos.

The pumping machinery consists of one centrifugal pump of the side-suction disk-lined type, constructed of steel and so designed as to withstand shocks due to the passage of stones, etc., which are often encountered in dredging. The pump is directly connected with the main engine shaft, all thrust being taken care of by marine thrust bearings. The main pumping engine consists of a three-cylinder triple expansion 14, 22½ and 40-inch by 20-inch vertical fore and aft condensing engine, which averaged 145 revolutions per minute during a year's work.

VIEW OF ELLICOTT DREDGE, SHOWING ARRANGEMENT OF MACHINERY

The agitating machinery is located at the bow of the dredge on a steel ladder of framework, resting on heavy steel trunnions. The suction pipe is carried on this ladder, the depth of the cut being regulated by raising or lowering the ladder. The agitating engine is located also on this ladder at its inboard end, and consists of a double condensing engine especially designed for very heavy work.

The boiler plant is the result of years of study, and consists of four wet back Scotch marine boilers, 10 feet 6 inches long by 11 feet 4 inches in diameter. These boilers may be worked in battery of three, reserving one for emergency, and may be operated with either coal or oil as fuel.

Just forward of the engine room is located the pump room. Besides the main pump, the fire pump is also located in the pump room; this pump serves to operate an improved ash ejector in addition to its use as a fire pump. A modern refrigerating plant is installed on the lower deck, which provides a cold storage room, besides making more than sufficient ice for the use of the entire plant. This dredge is also equipped with an electric plant, which provides current for all exterior lighting as well as for a large searchlight, thus enabling safe work at night.

Including the cost of pipe line and pontoons, this entire plant cost approximately $200,000 (£41,100).

During twelve months' work in Mobile Bay the *Wahalak's* rate of advance was 4.71 feet per hour, her average for dredging per hour 574.9 cubic yards, or, in an average day of 20 hours and 17 minutes, 10,108.7 cubic yards. The total of material removed during the year was 2,921,407 cubic yards, place measurement, within theoretical cross section. This work required the use of from 1,100 to 1,500 feet of 20-inch discharge pipe and from 56 to 51 pontoons.

The following shows the principal expenses of operating this dredge:

Cost of crew and subsistence	$34,892.45	(£7,060)
Fuel	15,585.68	(3,200)
Miscellaneous and engine room	3,421.38	(703)
Repairs, renewals, etc	12,758.37	(2,620)

In addition to this the cost of operating a tow boat and launch and repairs to same, together with the cost of operating the pipe line, brought the total to $80,002.86 (£16,400), which made the field cost 2.74 cents (1.37d.) per cubic yard. Other outlay, together with office expenses, brought the total gross cost to 3.24 cents (1.625d.) per cubic yard. The material removed consisted of clay, sand and mud.

Suction Cutter Dredger Governor General Idenburg

The dredger *Governor General Idenburg* was designed and built in the works of Messrs. Werf Conrad, of Haarlem, Holland, to the order of a Dutch firm of contractors for works in the port of Macassar in the Dutch East Indies. The principal dimensions are the following: Length on waterline, 215 feet; breadth, 37 feet 6 inches; depth at sides, 21 feet 3 inches; draft loaded, 18 feet; capacity of hopper, 28,000 cubic feet; maximum working depth, 67 feet. The two main engines are of the vertical triple expansion type, each capable of developing 500 horsepower when running at 150 revolutions per minute. These engines can be coupled either to the propellers or to the two sand pumps, so that the full engine power may be used for either purpose. A third engine of the horizontal compound type, developing 200 indicated horsepower, is fitted on the top end of the suction pipe and serves to drive the cutter gear. Steam is generated in two boilers having a heating surface of 2,150 square feet each.

This dredger is intended to work both in clay and in sand, in view of which it is provided with two suction pipes, viz., one pipe suspended in a well and provided with a clay cutting

SUCTION DREDGER BUILT FOR PORT USE IN THE DUTCH EAST INDIES

arrangement, and one ordinary suction pipe suspended on the port side of the vessel. The suction and delivery connections of both pumps are so arranged that the dredger may be worked in either of the following six different ways.

1. Suction openings of one or both pumps connected to suction pipe in well. Delivery openings of one or both pumps connected to (*a*) the hopper, (*b*) a pipe connection leading to the sides of the ship for delivery into barges alongside, and (*c*) a floating pipe line.

2. Suction opening of one pump connected to suction pipe in well, delivery opening of same pump connected to suction opening of the other, delivery opening of second pump connected to floating pipe line.

3. Connections as No. 1 substituting suction pipe at side for pipe in well.

4. Connections as No. 2 substituting suction pipe at side for pipe in well.

5. Suction openings of one or both pumps connected to hopper, delivery openings of one or both pumps connected to one or two floating pipe lines.

6. Suction opening of one pump connected to hopper, delivery opening of same pump connected to suction opening of the other, delivery opening of second pump connected to floating pipe line.

The diameter of both the suction and delivery pipes is 23½ inches.

The maneuvering of the vessel is effected by means of a central winch, manipulated from a pilot house in which all handles from the central and suction pipe winches are united. This central winch takes the wire ropes of two side anchors and two spuds.

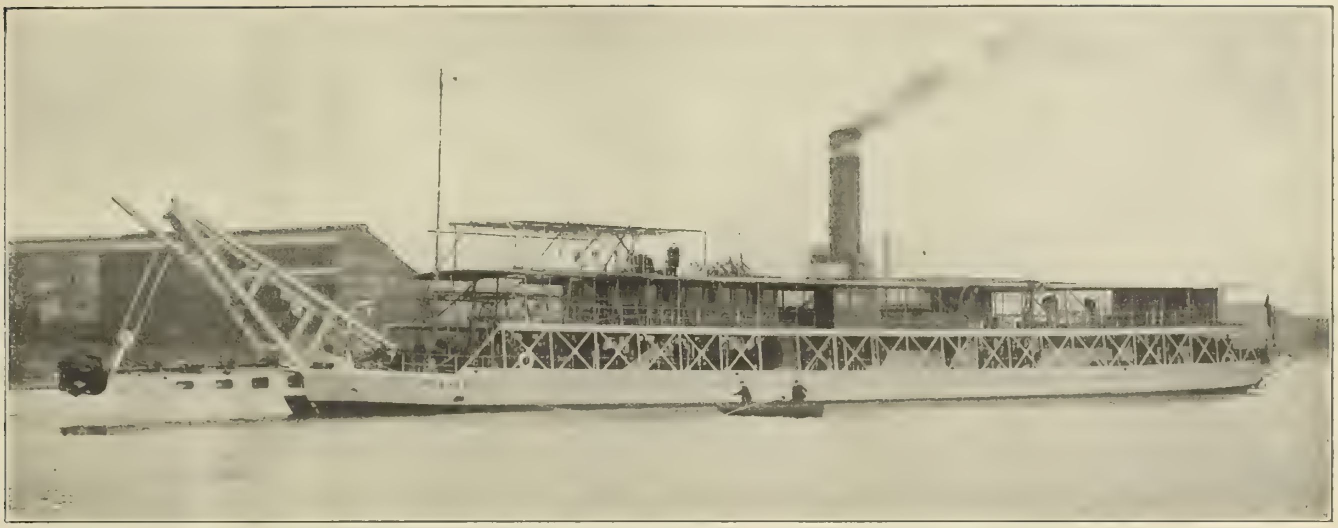


FIG. 1.—SUCTION CUTTER DREDGER OSWALD FOR INDIAN GOVERNMENT

Suction Dredgers

By the introduction in recent years of mechanical devices working in front of the suction nozzle remarkable developments have taken place in the application of suction dredging. Many different kinds of materials ranging up to the stiffest class of blue clay, chalk and rock have been attacked successfully. Previous to the introduction of these mechanical aids, suction dredgers could only be profitably employed in sand, or sand and silt, powerful water jets being employed when the sand was of a hard, compact or indurated nature, the disintegrating action of the water jets rendering the hard sand susceptible to the centrifugal force exercised by the suction pump. Water jets have still their place in suction dredging and are not at all likely to be superseded in certain classes of material for which they are specially suitable. With the construction of this suction cutter type of dredge the name of Messrs. Wm. Simons & Co., Ltd., of Renfrew, has been very closely identified.

This firm have just recently constructed and delivered under their own steam three large suction cutter dredgers, the *Oswald, Campbell* and *Lees* (see Fig. 1) for the Government of India. These dredgers are of the Simons suction reclamation type and will work in conjunction with a floating pipe line and terminal pontoon arranged for delivering dredged material over river or canal banks for land reclamation.

One of the great advantages which the cutter suction type of dredger has over the bucket ladder dredger is that the former, while capable of doing the work which formerly could only be done by the latter, is not saddled with so many parts subject to wear. The array of upper and lower tumblers, buckets, links, pins and rollers necessary in bucket ladder dredgers is subject to heavy wear and tear, and consequently much expense is incurred in keeping dredgers of the bucket type in good condition. The absence of so many wearing parts in cutter dredgers, on the other hand, naturally tends towards the reduction of maintenance charges. This feature must commend itself not only to contractors, but also to all harbor boards, government departments and other public boards who have much dredging work to do.

For dredging mud and soft clay, trailing suction hopper dredgers are indubitably the most suitable. One of the earliest dredgers of this type built by Wm. Simons & Co., Ltd., was the *Antleon*, in 1898, to the order of the New South Wales

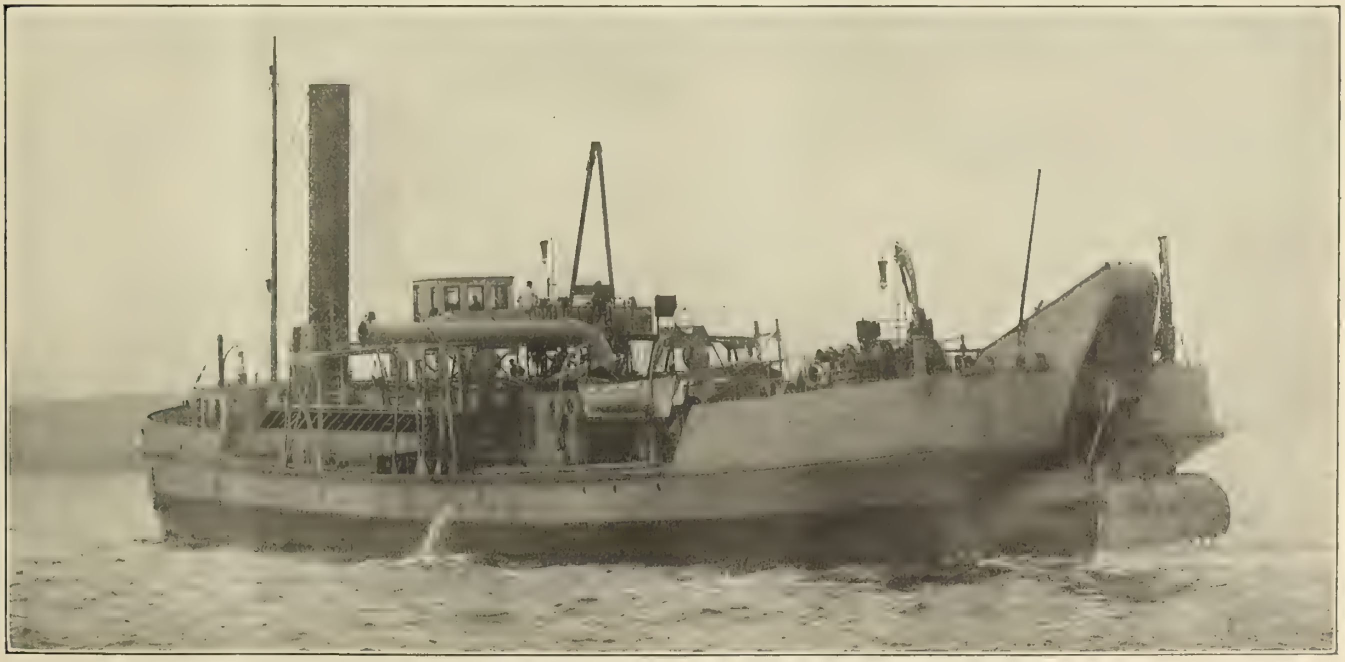


FIG. 2.—TWIN SCREW TRAILING SUCTION CUTTER HOPPER DREDGER CANTERBURY

Government. In these vessels neither anchors nor chains are used when dredging. The dredger steams slowly ahead and takes her load ready for dumping in deep water.

The latest type of dredger introduced by Messrs. Simons is the combined drag and cutter suction dredger. The suction frame is arranged to take either a drag nozzle or a rotary cutter. The drag nozzle is employed when mud or soft clay is being dredged and the cutter when hard clay or other similar material is encountered, which otherwise would not yield to the action of the dredging pump. Even with this meagre description the wide range on very different classes of material of combined drag and cutter suction dredgers will be at once apparent. The *Canterbury* (Fig. 1), constructed fully a year ago to the order of the Lyttleton Harbor Board, is the first vessel of this type. The results obtained by the *Canterbury* in her ordinary work have, according to reports received from C. I. R. Williams, Esq., H. I. C. E. Engineer to the Lyttleton Harbor Board, exceeded all expectations.

Grab Dredger Curraghgour

In our last annual dredge number mention was made of the construction of the grab dredger *Curraghgour,* built by the Dublin Dockyard Company, North Wall, Dublin. Since then this dredger has been given thorough trials, establishing the capabilities of the dredge. The hull is 146 feet long, 30 feet 6 inches beam, with a molded depth of 12 feet 6 inches. She

GRAB DREDGER DESIGNED FOR CUTTING HER OWN FLOTATION

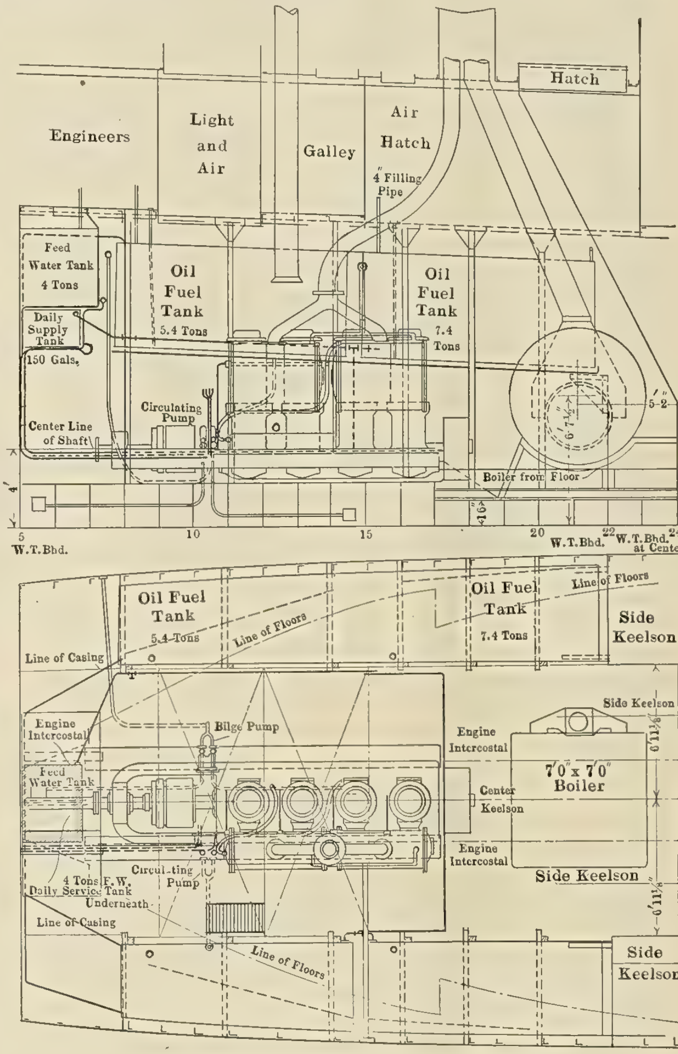
has a deadweight carrying capacity of about 520 tons of spoil, in addition to a week's supply of coal, all of which is carried on a mean draft of 11 feet. A special feature in the design of this dredge is that the forward crane has been so arranged and has sufficient outreach to allow dredging over the bow of the vessel, and consequently cutting her own flotation. The propelling machinery is fitted aft and consists of a set of compound surface condensing engines having cylinders 15 inches and 32 inches diameter by 24 inches stroke, steam being supplied by a cylindrical return tube boiler working at 120 pounds pressure. The two dredging winches for working the grabs, together with the grabs themselves, are of the most modern type of Priestman's pattern. The grab dredgers were found, on trial, easily capable of lifting the specified 160 tons per hour.

Monthly Shipbuilding Reports.—The Bureau of Navigation reports 135 sailing, steam and unrigged vessels of 34,078 gross tons built in the United States and officially numbered during the month of March, 1913.

British Motor Coaster Isleford

Considerable progress has been made in Britain and on the Continent during the past year in the building of high-powered Diesels for seagoing vessels, but when one comes to consider it great development has also taken place in the so-called semi-Diesel installation, or low compression residue oil motor; in fact, the latter type of engine bids fair to become a very serious opponent of the Diesel engine where powers up to at least 500 brake horsepower are concerned.

In Scotland alone there were turned out last year six motor coasters fitted with semi-Diesels of 80 brake horsepower to



MACHINERY ARRANGEMENT OF MOTOR COASTER

130 brake horsepower, while at the present moment no fewer than thirteen other vessels of this class are building in yards on the Clyde and Firth. Over 130 brake horsepower, however, neither Britain nor any other country has had experience of semi-Diesel machinery in sea service, hence the 350 brake horsepower Bolinders engined vessel *Isleford,* which ran her trials recently on the Firth of Clyde, is of the greatest interest at the moment.

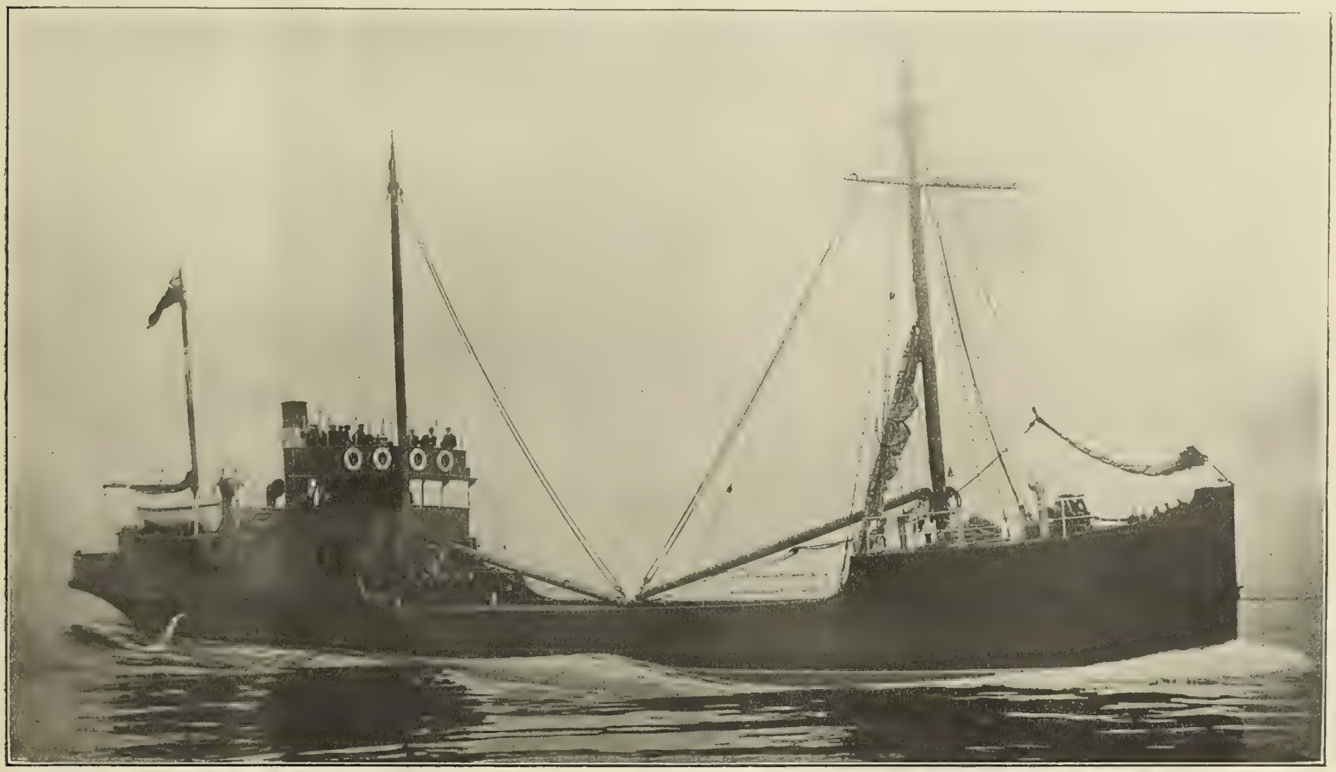
The *Isleford* was constructed by the Ardrossan Shipbuilding & Dry Dock Company, Ardrossan, for Messrs. Mann, MacNeil & Co., Glasgow. She is to Lloyds highest class and will be used in the general coasting trade. Her dimensions are 149 feet between perpendiculars by 25 feet 6 inches beam by 11 feet molded depth, and generally she is very similar to the usual steam coaster of the size, having the raised poop and forecastle decks, the long cargo hold amidships and the machinery space aft. The captain and officers are arranged for aft in the poop deck casings, while forward are the usual quarters for the crew. The vessel has a deadweight carrying capacity of 480 tons in a single cargo hold, which is entered by a hatchway of no less than 58 feet in length.

It is, however, the machinery of this vessel that calls for special mention. The main engines consist of a four-cylinder two-stroke cycle set of the above-mentioned make, the cylinders being about 16½ inches by 17 inches. The power is developed at 225 revolutions per minute, but the engine, we are told, is capable of being speeded up to 235 revolutions per minute. Reversing is on the pre-ignition principle and the same as seen on the smaller Bolinder models, only in the case of this big installation we noticed a remarkably neat device fitted which automatically throws in the governing mechanism as the clutch is withdrawn, and so prevents any racing of the engine. Blow lamps are, of course, employed for heating up prior to starting, and it may be here mentioned that only about twenty minutes is required for getting under way from cold.

The engine being of the solid injection type, and by this is meant that the fuel is pumped into the cylinder head in liquid form and so pulverized by compressed air, there is no cam shaft with its intricate gearing and no two-stage air compressor to absorb about 15 percent of the power. The circulating and fuel pumps are driven from eccentrics on the aft end of the crank shaft, while a 4-inch bilge pump is driven direct from the forward end of the crank shaft at engine speed. Compressed air, however, is used for starting up and maneuvering and the air tank, which under ordinary conditions is charged by the main engines, is arranged under the fuel tanks on the starboard side. There is a hand air compressor, however, fitted as a standby in case the air should at any time be lost when the engines are idle.

Fuel to the extent of 25 tons is carried in four tanks situated in the engine room. These tanks are all connected to a common service tank of 150 gallons capacity. On the supply from the service tank there is a large filter on which are mounted four hand pumps for charging the fuel pipes prior to starting.

The deck machinery, which consists of two powerful cargo winches, windlass, warping capstan and steering gear, is all steam-driven, steam being supplied from a 7-foot donkey boiler of the single-ended Scotch type, fitted with the Wallsend Howden patent fuel oil burning apparatus. This boiler, as will be seen from the drawings, is situated at the forward end of the engine room. There is also in the engine room a steam bilge and ballast pump, interconnected with the bilge pump on the main engines, and steam oil pressure and boiler feed pumps. In this oil-firing apparatus the fuel, which, by the way, is drawn from the main tanks, is injected into the furnace in the form of a conical spray of exceedingly fine particles by a special oil fuel pump. A small auxiliary oil heater, heated by means of a naphtha burner, is also supplied for raising steam in the boiler. Generally in these oil-fired sets we see a handle on the steam pump, but in this case there is a small independent hand pump which pumps the oil to the auxiliary heater, after which it passes through a duplex discharge strainer and thence to the burners. Once there is a sufficient head of steam in the boiler this hand pump is put out of action and the fuel is drawn direct from the tanks by the steam pump and delivered to the main heater, where it is heated to the required temperature.



MOTOR COASTER ISLEFORD RUNNING TRIALS

The contract for the machinery of the *Isleford* was, we may say, in the hands of Messrs. Douglas Primrose & Company, Glasgow, the Scottish agents for Bolinder's motors.

On Feb. 20 and 21 trials were carried out on the Firth of Clyde, when the machinery gave complete satisfaction. On the first day the vessel left Ardrossan fully loaded and proceeded to the Skelmorlie mile, where a mean speed of 9.05 knots, or half a knot over the guarantee, was attained. Later in the day maneuvering trials were held, when the reliability of the Bolinder reversing mechanism was well demonstrated. On the following day the vessel carried out a continuous run of about seven hours, in the course of which she was again taken over the measured mile. Throughout the trials it was pleasing to note the machinery ran without a hitch and gave no trouble of any kind.

Handling Freight at a Steamship Terminal

The New York Dock Company has recently installed a system of rapid freight-handling machinery for their export and import freight at the company's docks, located at the foot of Baltic street, Brooklyn, N. Y. The freight consists of the usual miscellaneous ocean-traveling freight of every description, of every size and of every shape, in boxes, barrels, crates, bales, kegs, flasks, sacks and sheet and bar metals. All this freight is handled by the machines to and from lighters, wagons, warehouse, freight house, railroad cars and delivery trucks.

The company's docks extend along the Brooklyn shore of New York Bay for about 2¼ miles, the property covering 300 acres and being entirely occupied with warehouses and railroad tracks. The freight is transported to and from the various warehouses by wagons and cars. The company has its own system of railroad tracks, which extend along the entire water front, and they use several dinkey locomotives for handling the cars. The only connection with the different railroads is by car ferries, which carry the cars back and forth to the railroads. These ferries connect with the company's tracks at the car-ferry slip, as shown on the plan view (Fig. 1), and the slip is so constructed as to provide for the rise and fall of the tide. There are 27 piers extending into the bay at which the large steamers dock for unloading and loading. The entire freight for these steamers is handled by lighters and wagons, as the railroad tracks do not run out onto the piers.

The handling machinery is used in connection with warehouse No. 117, which is used only for sorting and storing the export and import freight. It is a six-story brick building and is approximately 211 feet long by 68 feet wide. The only alteration in the building to allow for the installation of the machinery was the cutting of doors in the front and rear. The company buys its power from the Brooklyn Electric Light Company for lighting and operating the machines.

The machinery installed was the Brownhoist rapid freight-handling equipment. It consists of a single runway bridge on the wharf, a double runway bridge extending over the railroad yard and reaching the freight house, two I-beam tracks through the warehouse connecting the single and double runway bridges, and two man trolleys. The tracks on the two bridges consist of 15-inch I-beams, the same as the I-beam tracks connecting the two bridges. This gives a continuous I-beam track from the wharf, through the warehouse to the freight house, on which the man trolleys travel.

The single runway bridge extends from the warehouse door to the face of the dock, a distance of 76 feet, spanning two tracks and the wharf. It is equipped with a raisable apron, 28 feet long, which reaches out over the water. By means of a counterweight and a hand winch, this apron is raised and lowered, allowing the lighters to dock. This apron is also equipped with the I-beam track, so that the trolleys can run out over the boats with their loads. The I-beam track on the single runway bridge runs into the second story of the warehouse, and just within the door it branches into two I-beam tracks. The connection between the single track and either one of the two tracks is made by a switch which is operated from the floor by hand chains. The two tracks run to the rear of the warehouse and then turn to the right and pass by an elevator and out in the rear of warehouse 118 and connect with the two tracks on the double runway bridge. The I-beams are suspended from the ceiling in the warehouse by patent hanger bolts, and bolted together by patent joining plates. It was necessary to put a small curve in the two tracks at the point where they pass the elevator, owing to the location of the elevator, bringing the tracks closer together at this point. The double runway bridge is a stationary structural bridge, supported by two shear legs and the freight house. It is 103 feet long and spans several railroad tracks and crosses Baltic street.

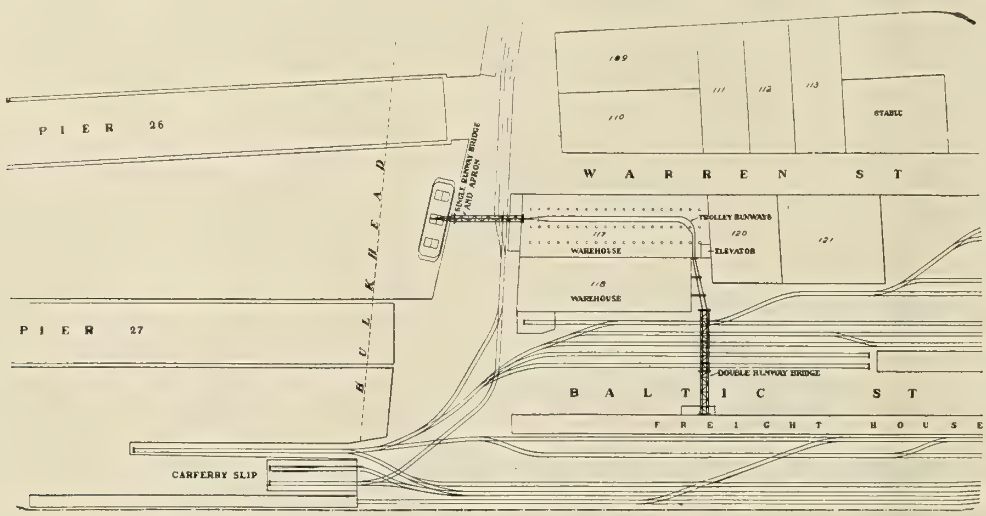


FIG. 1.—PLAN OF NEW YORK DOCK COMPANY'S PLANT AT THE CAR-FERRY SLIP

Two Brownhoist electric man trolleys, capacity 2¼ tons, are used for carrying the freight along the runways. Each trolley is suspended from two 4-wheel trucks by swivel and pin connections and it rounds all curves which have a radius of 15 feet or more. The truck wheels travel on the lower flange of the I-beam tracks, two wheels on each truck being connected to travel motors. The hoisting motor is carried on the front of the trolley and is geared to two hoisting drums. There are two hoisting ropes, one on each drum, from which a carrying frame is suspended on a sheave at each end. The limiting height of hoist is 30 feet. The trolley has a hoisting speed of 50 feet per minute, with full load, and 120 feet per minute with no load, and has a traveling speed of 450 feet per minute with full load and 550 feet per minute with no load. Each trolley is equipped with a hand traveling brake and with an automatic safety mechanical brake, as well as a solenoid

FIG. 2.—FREIGHT HOUSE END OF BROWNHOIST RAPID FREIGHT-HANDLING EQUIPMENT

brake for hoisting. The mechanical friction brake operates only on the downward direction of the load, and the solenoid brake operates when the hoist motor is not being driven. The load can be held at any desired height by means of these two hoisting brakes. All switches and controllers and the hand travel-brake lever are located in the cab just in front of the operator's seat. The current, 220 volts, direct current, is obtained through spring collectors with bronze collector wheels, which run on a copper trolley wire strung along the I-beam tracks. The trolleys travel in both directions.

For carrying the freight the company uses twelve special 2-ton Brownhoist trucks. The truck is equipped with ballbearing wheels, two 10-inch wheels at one end and two 2-wheel swivel casters at the other end, and with full load it is easily pushed around on the floors and in and out of freight cars. Each truck is 8½ feet long by 3½ feet wide, overall dimensions. At each end of the truck there is a structural frame to hold the load, and on top of each end frame there is a hook plate, which engages the hooks on the carrying frame of the trolley. For carrying sling loads of miscellaneous freight the carrying frame is equipped with a swiveled hook in the middle.

The company receives its freight by ocean steamers from foreign countries, by lighters and barges from points along

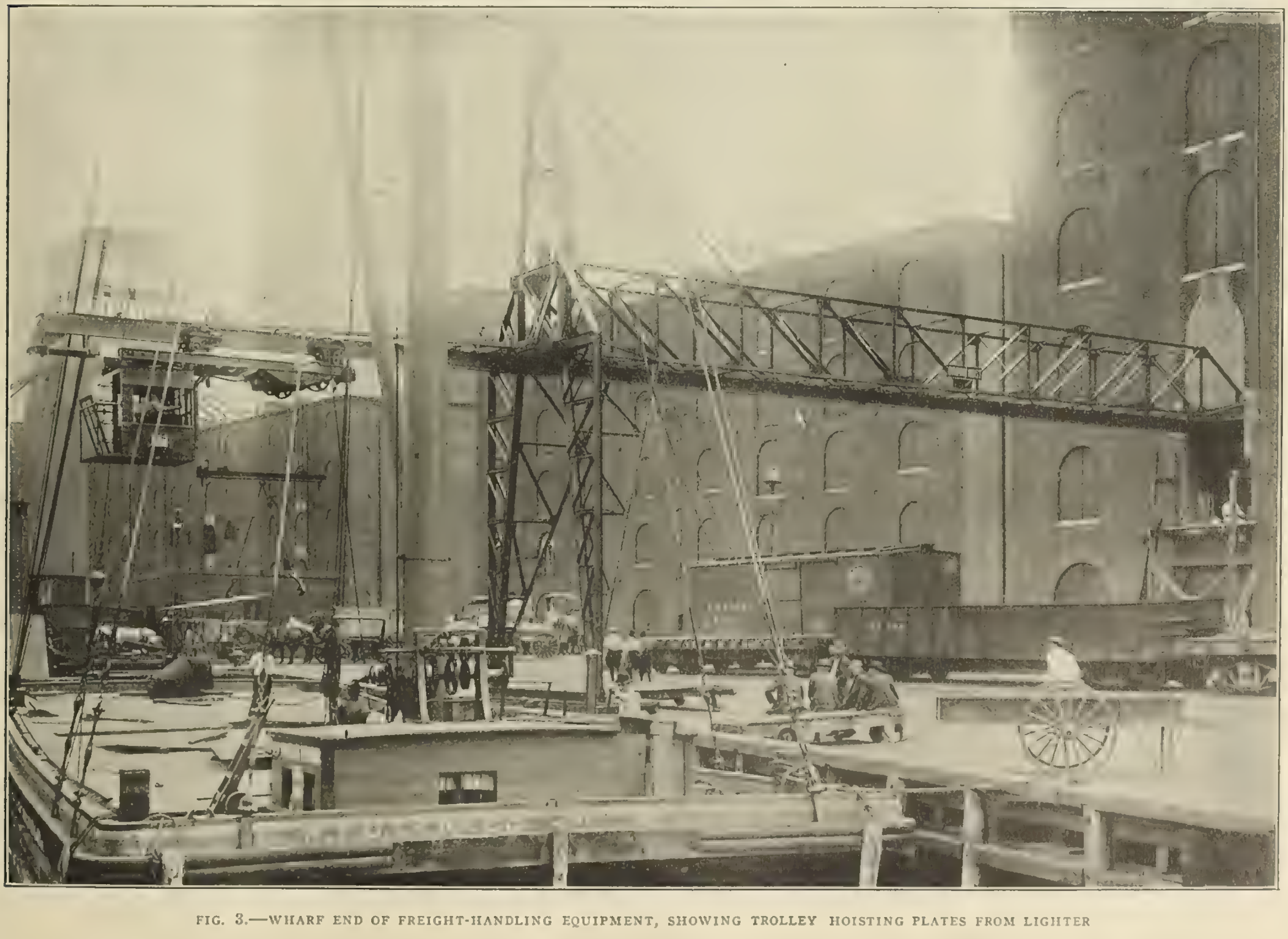


FIG. 3.—WHARF END OF FREIGHT-HANDLING EQUIPMENT, SHOWING TROLLEY HOISTING PLATES FROM LIGHTER

the river and along the coast, by railroad cars from different parts of the country, and by delivery trucks from the city. Freight is also shipped out by these various means. The ocean steamers dock at the various piers and unload their cargo onto the piers and lighters. On the piers the freight is carried by hand trucks to the various storage places, and then handled by wagons from the storage places to the various warehouses. The lighters are unloaded by the trolleys, which carry the freight to the freight house or into warehouse 117 if for reshipment by water. The ocean steamers are also loaded by the lighters and wagons with freight coming from the warehouse, freight house and cars.

freight which is to be stored for several days into the warehouse and deposits it at the door of the elevator. The truck is pushed onto the elevator and carried to one of the four floors above, where it is held until the steamer arrives. When the steamer arrives the freight is loaded onto trucks and carried down by the elevator to the trolleys, which take it out to the lighter or to the wagon, as the case may be. If the freight is not fragile and is of small size it is sent down the chute to the second floor and there loaded onto the trucks. This latter operation saves the time of coming down the elevator. When each trolley deposits a load it picks up another one without losing time for loading or unloading. As yet

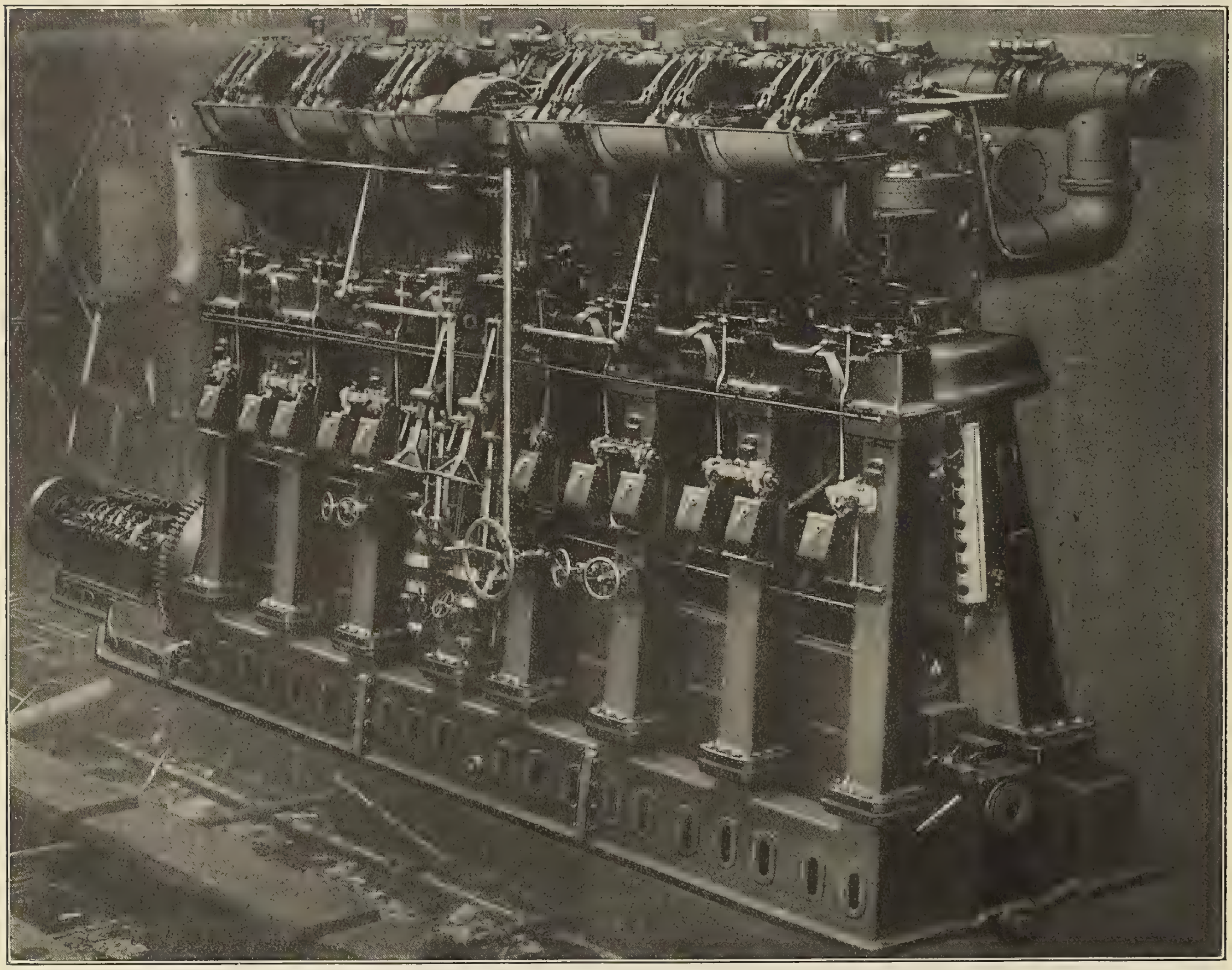


FIG. 1.—ONE OF THE HAGEN'S MAIN ENGINES ERECTED IN THE BUILDERS' SHOPS

Freight for export coming in by cars in carload shipments is unloaded directly onto the lighters or wagons to be taken to the steamer, but if the steamer is not in, the freight is taken into warehouse 117, where it is held until the steamer's arrival. Freight coming in by cars in less than carload shipments is unloaded at the freight house, sorted and delivered to the local trucks or to other cars, or to warehouse 117 if for reshipment by boat. Freight delivered to the freight house by local shippers is sorted and loaded into cars or taken to the warehouse to await the arrival of the boat.

The trolleys do the unloading and loading from and to the lighters, wagons, cars and gondola cars, either with the trucks or by sling loads depending upon the character of the freight. In warehouse 117 the trolleys work in conjunction with the elevator and with a chute which runs from the top floor down to the second floor. The trolley carries a truck loaded with

the plant is not running to full capacity, but so far the equipment has replaced 12 men in the warehouse and freight house.

The trolleys handle all the freight as fast as it can be delivered to them, which enables the company to make prompt shipments, whereas heretofore when hand labor was used many shipments suffered considerable delays. This means a saving in demurrage charges and is giving the company a reputation for prompt shipments. The equipment has eliminated the congestion of wagons on the dock. Furthermore, in the handling of the freight to and from the cars the handling charges have been cut in half.

J. W. Galbreath is the consulting engineer for the New York Dock Company, and F. R. Lackey is general manager of the New York Dock Railway. The handling equipment was built and installed by the Brown Hoisting Machinery Company, of Cleveland, Ohio.

German Diesel Engined Tank Ship Hagen

The rapid increase in the consumption of mineral oil of all classes has had in the last few years the result of a very strong demand for tank ship tonnage. This at the present time represents, with its resulting new construction, the most active branch of shipbuilding all over the world.

The new ships, numbering over 100, partly of extraordinary size, surpass the average of previous years almost ten times. Of this number the German-American Petroleum Company alone has ordered about one quarter. Of the 16 tankers at present building in Germany for their account, 3 are of special interest as being engined by the Germania shipyard with oil engines.* The development of the Diesel engine to large units, well suited for the main engines of ships, made its application particularly desirable for tank ships, as in them the full economy of the Diesel engine could be realized with the lowest fuel consumption and first cost. A further advantage is the absence of any open flame in the Diesel engine and consequently a decreased danger of explosion.

The oil motor tank ship *Hagen,* built and engined by Fried. Krupp A. G. Germania shipyard, and illustrated herewith, was launched Nov. 28, 1912, as the first of the oil engine tankers ordered by the German-American Petroleum Company from the Germania shipyard. It is the first German seagoing vessel with oil engines of a German make.

The ship is built after the transverse frame system for the class of the English as well as of the Germanic Lloyd Society under special survey of both companies. The main dimensions are: Length between perpendiculars, 400 feet; beam, molded, 53 feet; depth at side to upper deck, 32 feet 4 inches; deadweight with summer freeboard, 8,200 tons; engine, brake horsepower at 140 revolutions per minute, 3,000; speed under full load, 11 knots.

The *Hagen* is a twin-screw ship with machinery spaces aft. The arrangement of placing the machinery aft is not unusual for tank ships, as this avoids an interruption of the longitudinal centerline bulkhead and also avoids the oil-tight shaft alley through the after oil tanks.

The ship is fitted with poop, bridge house and forecastle above the main or upper deck. The hold, extending from the keel to the 'tween deck, is divided into seven equal tanks and bounded fore and aft by the required cofferdams. A third cofferdam and the pump room further arrange the tanks in three groups, giving thereby the chance of handling different kinds of oil without danger of mixture by leaky bulkheads. Each of the seven tanks is divided in halves by an oil-tight longitudinal centerline bulkhead, which extends from the keel to the upper deck. Whenever the cargo is of the same grade of oil also the third cofferdam can be filled with it. Between the upper and 'tween decks on each side of the centerline bulkhead are tanks extending the entire length of the lower tanks, but only about one-half their width. These expansion tanks allow the oil to rise in its level and also with sufficient height prevent a swashing over of the cargo under transverse rolling of the ship. The small tanks outside of the expansion trunks above the 'tween deck are the so-called summer tanks, which have to be employed as cargo tanks with oils of low specific gravity, to realize the full carrying capacity of the ship.

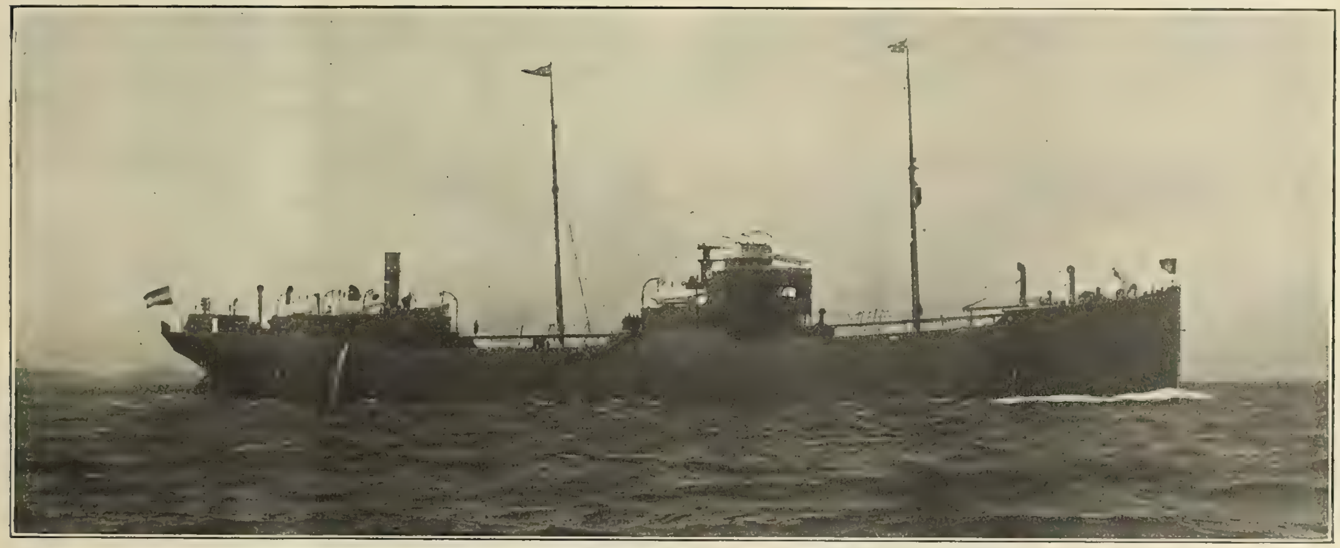


FIG. 2.—OIL MOTOR TANK SHIP HAGEN, BUILT AND ENGINED BY FRIED. KRUPP A. G. GERMANIA SHIPYARD

Every main hatch has a steel cover which is securely bolted down, and removed only upon occasions of large repairs or when the hold has to be used for general cargo. A smaller hatch or manhole is in the large cover, and in its cover are the connections for the filling pipes or hose. The summer tanks have only small hatches. The gases that will evolve from the cargo are carried off by pipes from the hatches to the masts and carried well up. A valve which automatically opens under a certain excess pressure, as well as under a certain vacuum, closes every pipe line at the mast and prevents too large an evaporation from the cargo. The cargo is discharged by two steam piston pumps, each of 250 tons capacity per hour, either over the side or over the stern of the vessel. Each tank can be filled or discharged separately and independently. All pumps are arranged in the pump room, and the oil-handling pumps are with all their pipe systems completely separated from the water-handling pipe lines, and the latter are also kept entirely clear from the oil tanks, so that the danger of oil leakage is reduced to the very minimum.

The gases that remain in the tanks after the discharge of the cargo are removed by a powerful fan, using as its inlet piping the pipe lines for the oil discharge. Steam pipes extend nearly down to the bottom of each tank for the purpose

* The shops of Fried. Krupp A. G. have furnished or have on order 69 marine oil engines totaling about 65,855 brake horsepower, aside from 146 stationary oil engines of about 26,634 brake horsepower.

of steaming the tanks and of extinquishing a possible fire. All pipe lines, as well as the two wire electric conductors, are arranged on the upper deck, partly on iron brackets, partly under the fore and aft flying bridge between the deckhouses. This flying bridge is for the regular communication by the crew, as the upper deck with its oil hatches shall be used only when repairs have to be made there, thus securing the greatest safety against possible fires. These arrangements reduce even the dangers that might arise from a cargo of gasoline (petrol) or benzine to the very minimum.

The oil tanks serve as tanks for water ballest, and in addition two peak tanks and a large tank in the fore hold serve as tanks for trimming the ship. The tanks for water ballast are discharged by a steam ballast pump of 100 tons per hour capacity. It is located forward.

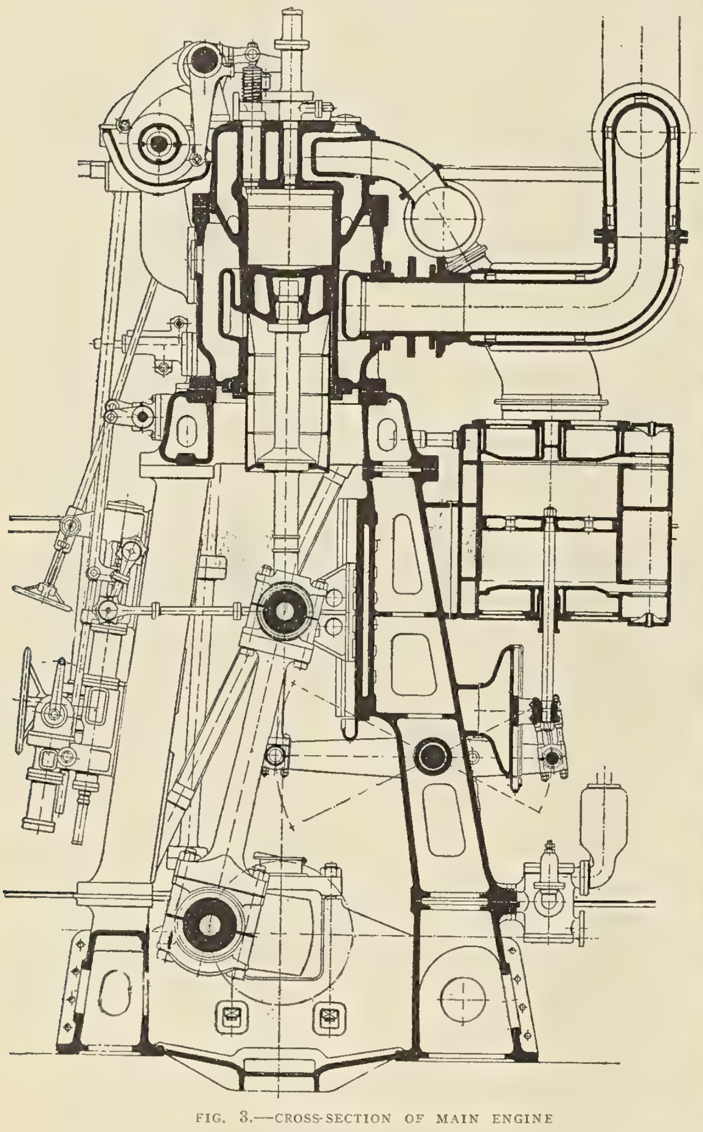


FIG. 3.—CROSS-SECTION OF MAIN ENGINE

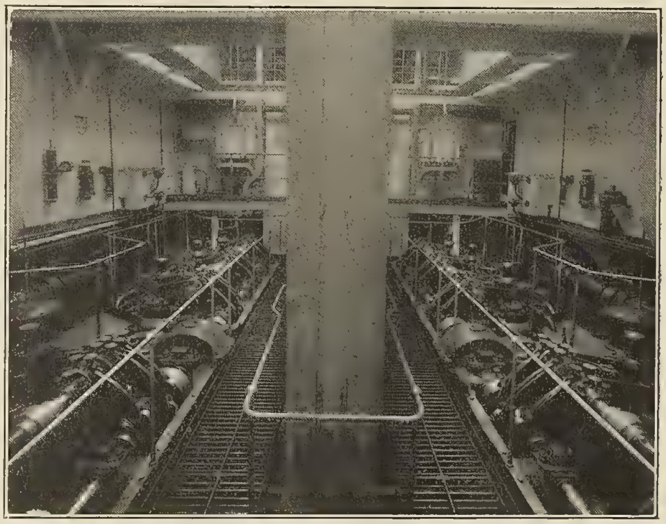


FIG. 4.—UPPER PLATFORM IN ENGINE ROOM

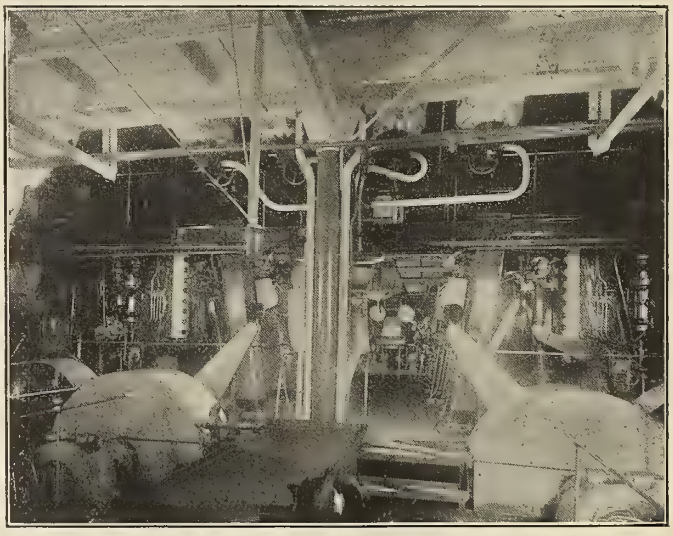


FIG. 5.—LOWER PLATFORM IN ENGINE ROOM

The ship has a double bottom aft under the engines which serves partly for storing the feedwater for the donkey boiler and partly for ballast purposes. Arrangements have been made also to carry fuel oil in the inner bottom, in case an extra large amount of fuel is necessary for unusually long voyages. For the trips between Europe and America, for which the ship is mainly built, the normal bunkers of 500 tons capacity are sufficient. These bunkers are arranged around the engine room and hatch, partly in the hold, partly on the 'tween deck. Reserve bunker space is furnished by the after cofferdam. Two small day tanks are arranged in which the oil can settle and free itself from water and sediment. The accommodations for the crew are as usually provided in tank ships. As the number of firemen is greatly reduced, it was possible to fit under the forecastle a carpenter shop. The engineer force, with the exception of the donkeyman, are quartered under the poop. Compared with a steamer of equal type and size, which needs about 25 men in the engineer department, the *Hagen* needs only 4 engineers, 3 assistant engineers, 2 helpers and 3 oilers, or in all only 12 men.

In outside appearance the *Hagen* does not differ greatly from a steamer, as a smokestack of normal size has been fitted, which includes the exhaust pipes and the smokestack for the donkey boiler. Two light, tall masts of welded pipe serve for signal purposes and for supporting the antennæ of the wireless telegraph installation, with which all recent ships of the German-American Petroleum Company have been fitted. Four derricks are fitted, supported by separate columns, two for service at the forward cargo hatch and two at the after hatches for stores, provisions, etc.

Of special interest on an oil-engined ship are the auxiliaries. On the *Hagen* steam is provided for service in port for nearly all auxiliaries by an oil-fired donkey boiler of the two-furnace Scotch type. Where open fires are prohibited on the petroleum docks, steam is carried to the auxiliaries from shore. The anchor windlass, docking winches, oil pumps and forward

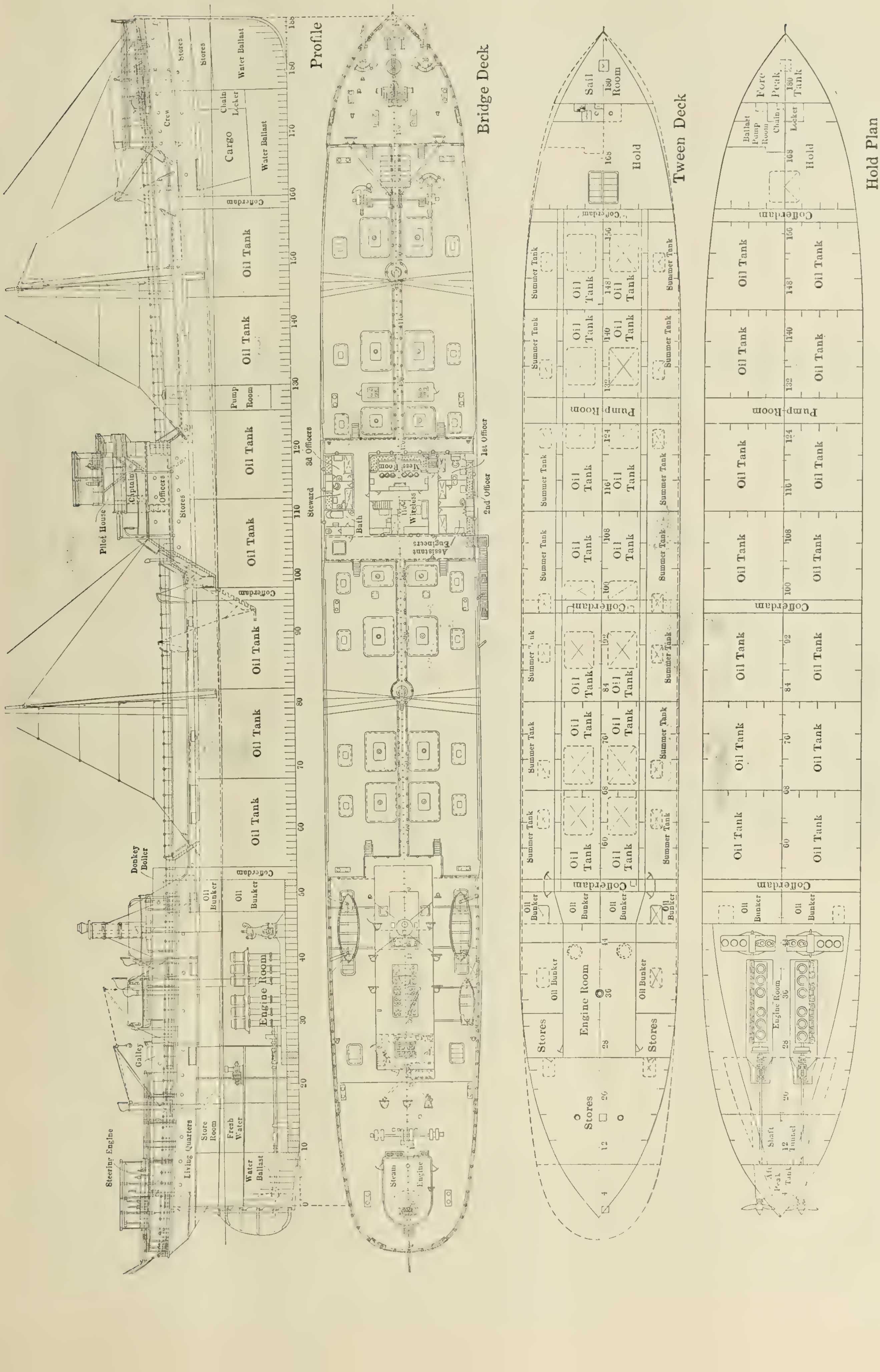


FIG. 6.—PROFILE AND DECK PLANS OF THE HAGEN

ballast pump, which are not used at sea, are therefore all fitted for steam drive. The steering engine is driven at sea by compressed air. But in docking and port service, where the consumption of compressed air is large, due to frequent reversing, it can also be driven by steam to save compressed air. It is placed in a house on the poop, acts directly by a pinion upon the loose quadrant and is actuated by a telemotor from the bridge.

Electric current for light and power purposes is furnished in port by a direct-connected steam generating set; at sea current is furnished by a set driven by a two-cycle hot bulb oil engine; the two direct-current dynamos each furnish 23 kilowatts at 110 volts.

The most important pumps are: Two steam pumps for cargo of 250 tons per hour capacity each in the pump room; one steam pump for water ballast of 100 tons per hour capacity in the forward cargo hold; one steam pump for bilge and ballast pumping of 100 tons per hour capacity in the engine room; one steam pump for filling oil bunkers of 100 tons per hour capacity in the engine room; two electrically driven centrifugal pumps for bilge and ballast pumping, deck washing, etc., one of 30 tons and one of 80 tons per hour capacity; one electrically driven piston pump for filling the day tanks with bunker oil of 20 tons per hour capacity.

At sea steam is not available and the heating of the ship is therefore done by hot water, which at sea is heated by the exhaust gases of the main engine and kept in circulation by a small centrifugal pump. If the main engines are not running the water is heated by steam. Also the steam tables in the pantry are heated from the hot water plant. Hot water for bathing and dishwashing can quickly be furnished from a bypass on the discharge pipe of the cooling water of the cylinders. In port the water for bath, showers and dishwash sinks is heated by steam fixtures. Cooking at sea is done on a coal range, but at the petroleum docks by steam, as there no open fires are allowed.

The conditions under which the ship has to work seem to make the installation of a donkey boiler the best solution of the question of auxiliaries.

The two main propelling oil engines of the Diesel type work on the single-acting two-cycle system. According to the contract each engine should furnish 1,150 brake horsepower at 140 revolutions per minute, but on the testing floor each engine developed 1,500 brake horsepower at 140 revolutions per minute. They resemble in their appearance regular marine steam engines. Every engine has six working cylinders and two scavenging pumps, which are driven by rocking levers from the crossheads of the two center working cylinders. By this arrangement the engine halves, consisting of three working cylinders and one scavenging pump each, are made completely independent from each other and can be so operated. This also gives a chance for a reduction of speed for handling purposes and of safety against collisions. The number of revolutions per minute can without difficulty be reduced to 28, or about one-fifth of the normal number of revolutions. Each rocking lever of the scavenging pumps serves also for driving two pumps. Of these four pumps two are for supplying cooling water to the cylinders, the cylinder covers and the exhaust pipes up to the mufflers, the third is for cooling the pistons, while the fourth serves as a bilge and sanitary pump.

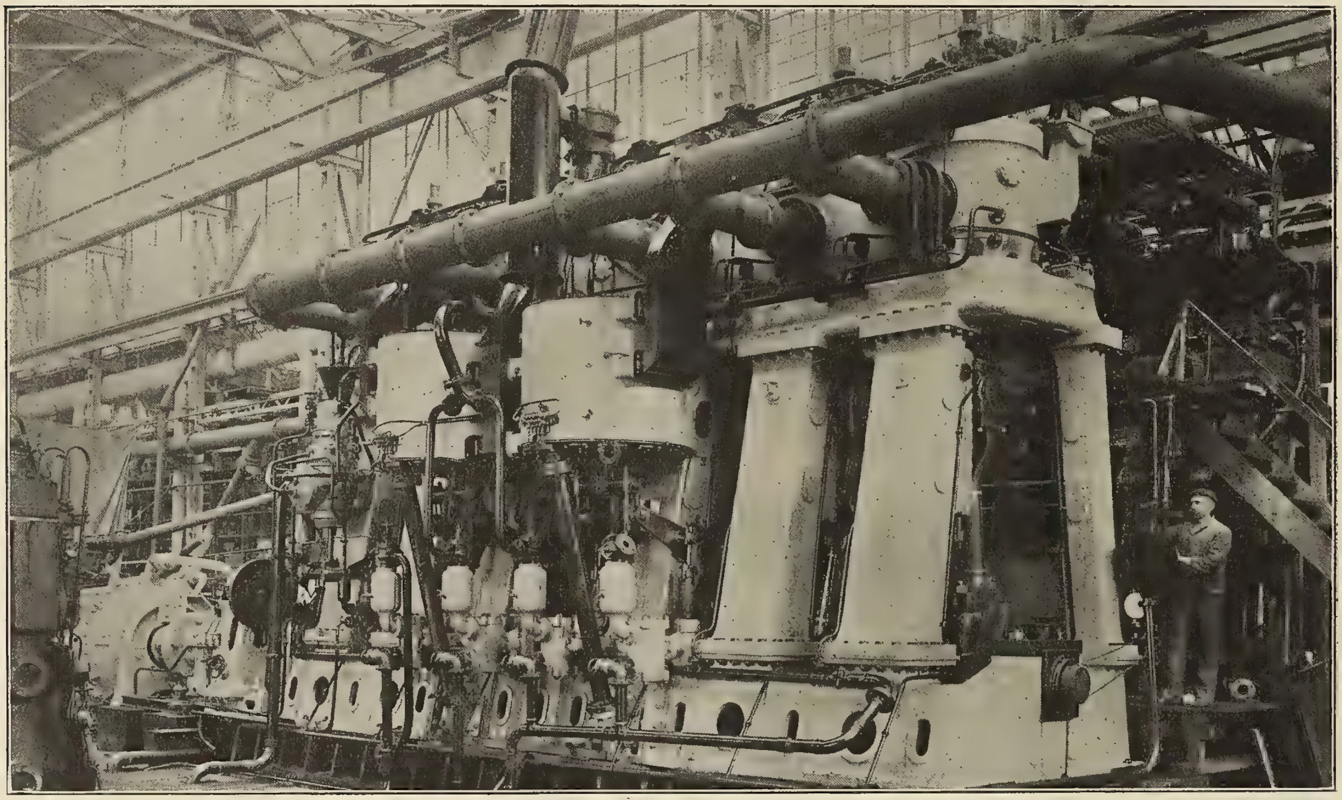


FIG. 7.—REAR VIEW OF ONE OF HAGEN'S ENGINES, SHOWING PUMPS

The crosshead of the after working cylinder also drives by rocking levers a two-stage air compressor, which furnishes the compressed air for the steering and auxiliary engines. These levers also drive one pump for supplying lubricating oil and one for furnishing fuel oil.

The engine bedplates are of cast iron, each in three parts, with oil-tight wells to catch the drip from the engines. The main bearings are of the construction usually found in merchant vessels with wrought steel caps and cast iron boxes lined with white metal. The crank shafts are each of two interchangeable parts with three cranks, so that one-half crankshaft as a spare is sufficient and fits either the forward or after half. Upon the bedplate are mounted cast iron columns which carry the water-cooled crosshead guides and above the cylinder base. Good accessibility to the moving parts is secured by this arrangement of the columns.

The working cylinders are composed of the outer shell of cast iron cast in one piece with cleaning holes and of the inner working barrel, also of cast iron, which is cast together with the cylinder cover. The exhaust pipe is carried through the outer shell by a stuffing box. This arrangement allows a very convenient cleaning from deposit or sediment of the cooling water for the cylinder barrel, as well as the cylinder cover.

The pistons are of cast iron and composed of an upper water-cooled part, which contains the snap piston rings and a guide barrel, which covers the exhaust ports. To prevent still more surely any escape of the exhaust gases into the engine room, every guide barrel is fitted with a special stuffing box.

The cooling water for the piston is carried by jointed pipes to the crosshead and from this through the hollow piston rod to the piston. A pipe inside of the bore of the piston rod furnishes separate inlet and outlet passages for the water. The piston rods are in two parts to allow a removal of the pistons downward without having to remove the crossheads and the connecting rods.

Cylinder lubrication is furnished by special pressure oil pumps which are supported from the cylinder base. Lubrication of the moving parts is from drip oilers, which deliver into suitable cups of the parts. As an extra precaution hand oiling is provided for which allows in case of necessity the concentration of large amounts of oil upon certain parts. The main bearings and those of the valve gear shaft are fitted with large oil reservoirs, which feed their contents by wicks to the surfaces. All escaping oil is collected in the crank pits, from which it is drawn off by an oil pump and delivered to the filtering tanks.

The fuel oil is delivered to the engines from an elevated tank, the oil level of which is held always at the same point, thereby furnishing oil to the fuel pumps, always under constant pressure. A special pump delivers the oil to this elevated tank from a measuring tank in the engine room. This latter is arranged so low that the oil flows to it by gravity from the bunkers. Only when the oil has to be taken from the double bottom does it need the service of an electrically driven piston pump of about 20 tons per hour capacity.

The valve gear of each cylinder consists of two scavenging air valves, one fuel needle and a ring of exhaust slots, opened and shut by the piston. Including the compressed air starting valve, every cylinder cover therefore carries four valves. A horizontal valve shaft which extends the entire length of the engine drives all valves with cams, rollers and bell crank levers, which latter are mounted on two reverse shafts. The valve shaft can be shifted longitudinally and carries an ahead and backing cam for each valve separately. The valve shaft is driven by heloidical gears from a vertical shaft, which also serves for the operation of the fuel pumps. These latter can be adjusted by hand to suit any desired number of revolutions. On the upper end of the vertical shaft is a centrifugal governor, which prevents an excessive number of revolutions under pitching of the ship or in case of the breakdown of the shaft.

For reversing the reverse shafts are usually shifted by compressed air, or in emergency by hand, so that the rollers are off the cams; then the valve shaft is shifted by a hand wheel and worm gear far enough until the backing levers can bear. The reverse shaft has three main positions, viz.:

1. Full ahead, when the fuel needles and the scavenging valves work, but the starting valves do not work.

2. Stop, when the fuel needles and starting valves are not working.

3. Starting, when the fuel needles do not work, but with the starting valves in operation.

The mechanism for the shifting of the cam shaft is completely separated from the arrangements for starting and stopping the engine, as well as for the change from starting air to fuel oil. By interlocking stops the possibility of a wrong operation is entirely excluded. All of the handling and reversing gear is clearly arranged and has proved itself quite reliable.

To make sure of always having the necessary compressed air for starting, reversing and injection of fuel in the required quantity, two independent oil engine compressors are provided, each of which can furnish the required compressed air for both main engines under normal operation. Should by accident all main and auxiliary compressed air reservoirs be empty, then they can be filled by a small three-stage compressor which is attached to the oil engine of one of the generating sets. An absolute certainty of air supply is thereby secured.

The oil engines of the main compressors are single-acting three-cylinder four-cycle engines, each of 275 brake horsepower at 300 revolutions per minute, and are very similar to the reliable stationary Germania type. On account of the high number of revolutions, forced lubrication for all moving parts is provided and therefore a closed crank case is fitted, which has large covers, however, to allow full access to the parts. No crossheads are fitted, the connecting rods take hold of the wrist pins within the trunk pistons. The pistons are water cooled and the water is led to them by telescopic pipes in the manner patented by the Germania shipyard. The exhaust gases are used for heating the compressed air for the steering engine.

A two-cylinder three-stage air compressor is connected directly to each engine and liberally proportioned intercoolers provide for the necessary cooling before entering the next stage. The compressor is built for 1,100 pounds per square inch maximum pressure, but usually a much lower pressure is sufficient for normal operation. After leaving the compressor the air is cooled again and stored in the injection reservoirs of the main and compressor engines and in the large steel pressure tanks for the starting air.

The weight of the entire machinery plant of the ship, including the propelling engines with shafting and propellers, all auxiliaries and generating sets, the donkey boiler and its feed water amounts to about 580 tons. The fuel consumption of the main engines is 180 grammes per brake horsepower hour or 0.4 pound. On trial, in spite of the stormy weather, the vessel attained a speed of about 12½ knots, or about 1½ knots above contract speed.

In the design of the engines the greatest importance was placed upon absolute reliability, even under the severest sea duty, and further upon low fuel consumption, easy accessibility to and removal of parts and quiet running. The realization of weight reduction was less considered. In cases where the smallest possible weight with sufficient reliability is the first question and fuel economy comes later, there the weight of oil engines can, of course, be most materially reduced.

The success which the *Hagen* has realized on the trials proves again that the Diesel engine is to-day fully prepared to fulfill all expectations, even of the largest ships, as regards reliability and handiness. In economy it is quite superior to other machinery types. A further advance on the road, of using it even for the largest seagoing vessels, is furnished by the third tank ship, for which the German-American Petroleum Company has given an order to the Germania shipyard. With its capacity of 15,000 tons and its 4,000 brake horsepower in the two main engines it will be the largest oil engine ship so far constructed.

To the Germania shipyard is due the credit of having materially contributed to the rapid development of the oil engine, formerly with stationary and submarine engines, and now with these three tank ships.

McAndrew's Floating School

BY CAPT. C. A. McALLISTER*

"To prevent too great a radiation of heat from the cylinders they are lagged with blocks of a non-conductor, such as magnesia or asbestos, 1½ to 2 inches thick, held in place either by wood staving or planished sheet iron. This accomplishes two purposes: one of making the engine more efficient by preventing the loss of heat, and the other of keeping the engine room from becoming too hot for comfort.

"O'Rourke, do you know what a non-conductor is?"

"It must be a conductor that don't belong to the union," replied the Irishman.

"Oh! I'm not talking about street cars," testily replied McAndrew. "There are certain substances which transmit heat very readily, and they are termed 'conductors'; others which transmit heat very slowly are known as 'non-conductors.' It is often said that man cannot improve upon nature, and this is verified by the fact that hair-felt, made principally of cow hair or horse hair, is about the best non-conductor we can use. Hair-felt will burn or scorch if placed on surfaces which are too hot, such as the cylinders of an engine using high-pressure steam, hence combinations of asbestos and magnesia make the best non-conductors for that purpose.

"The next parts of a marine engine to be considered are the pistons and piston rods. The pistons are made either of cast iron or cast steel; sometimes for lightness, as in the case of those used in torpedo boat engines, they are made of wrought steel. If they are made flat and of box section, that is, with double walls, the material used is cast iron. However, the majority of pistons are cast solid of conical section to provide the necessary strength, and in this shape are almost invariably of cast steel. In first-class work they should be machined all over, so as to reduce the clearance spaces as much as possible. It is necessary, no matter what the type of piston used, to provide some means of preventing the steam from leaking past the piston. This is accomplished by rings fitted in grooves in the rim of the piston, which either from their natural elasticity or from being forced outward by springs of various forms, keep tight against the wall of the cylinder and prevent the leakage of steam. These rings are always made of cast iron, as no other metal will suffice. Great care is usually taken to prevent the steel pistons from wearing against the sides of the cylinders, as steel on iron is a bad combination where the surfaces are not thoroughly lubricated.

"The piston rods, which transmit the motion of the pistons to the crossheads, are simply cylindrical columns, securely fastened to the pistons at the top and the crossheads at the bottom, by means of fitting into tapered holes, which take up the thrust in one direction and nuts which prevent movement in the other direction. Piston rods are almost invariably made of wrought steel, and to save weight are sometimes made hollow. Now I think I heard one of you fellows say, sometime ago, that a hollow piston rod is stronger than a solid one, or was it a hollow shaft you were talking about? Anyhow, you want to forget that, as I find too many people get that foolishness in their minds. A hollow rod or a hollow shaft is stronger than a solid one of the same weight, that is of the same amount of metal used, but you can see that if only the same amount of metal is used the solid rod or shaft will be of a smaller diameter. So hereafter you can say, for example, that a 6-inch hollow rod with a 3-inch hole through it is not as strong as a 6-inch solid rod, but that it is stronger than a 5¼-inch solid rod which contains the same amount of metal. Even then it is only stronger when the rod is being pressed down or in compression, as it is called; when it is being pulled, or is in tension, it would be of the same strength, whether hollow or solid, as there would be the same sectional amount of metal to transmit the pull."

"Why don't they make piston rods square instead of round?" inquired the studious Nelson.

"I'm glad you spoke of that," replied the instructor. "So far as actually transmitting the work is concerned I suppose a square rod would do as well as a round rod, but the rod must pass through the bottom of the cylinder so as not to allow the steam to escape. It would be very difficult indeed to build a stuffing-box around a square rod and keep it tight, whereas with a round rod it is comparatively simple. Another reason is that it is much cheaper to machine a round rod than it is a square one. In passing it will be well to consider the manner in which steam is prevented from leaking out of the cylinders around the piston rods and valve stems. In the olden days when the steam pressures and consequent temperatures were low, it was quite an easy matter to keep rods tight by a simple stuffing-box with an adjustable gland, packed with hemp or other form of soft packing. Nowadays the steam pressures and temperatures are so high that they would soon burn or blow out hemp packing, and the result is that metallic packing has to be used. This has been a fertile field for the inventor, with the result that almost every day a chief engineer, when in port, will be met by a man with a new kind of packing, guaranteed to be better than any other kind ever made and capable of saving at least 10 percent in the coal bills. Metallic packing usually consists of rings of cast iron, white metal or composition, held against the rod by the compression of springs of ingenious forms. The best of them is the one that keeps the rod the tightest with the least amount of friction."

"What kind is that?" said O'Rourke.

"You can search me," replied McAndrew. "Now, having described the principal features of cylinders, we must, in regular order, find what they stand on, or what it is that supports them, as you all know that the cylinders must be held in place as rigidly as possible.

"What name is given to these supports, O'Rourke?"

"'Colyums,' sir!" replied the one addressed.

"Oh! you are learning fast," said the instructor, "nearly all old-timers refer to them as 'col-yums' instead of 'col-umns,' as the word should properly be pronounced.

"Columns are made of numerous designs—of cast iron, cast steel and wrought steel. Some engines are supported on cast iron box-section columns at front and back, but I think the majority of marine engines have cast iron inverted Y-columns at the back and cylindrical wrought steel columns at the front, as shown in Fig. 6, where sections are shown also. In nearly all merchant vessels' engines the condenser is built in the engine frame and forms a part of the support for the cylinders. Short columns, to which the guides are attached, are bolted to the top of the condenser."

"I thought guides were men who show 'rubes' around the city; how do they get in on this engine game?" inquired the 'butter-in' of the class.

"On a marine engine," replied McAndrew, "the guides show the crosshead slippers how to walk the straight and narrow

* Engineer-in-Chief, United States Revenue Cutter Service.

path; if they permitted them to roam around very much there would be trouble. In that respect they differ from the average two-legged guide such as you have met on shore.

"The guides shown in the above sketch attached to the Y-columns are the kind used most extensively for marine work. When the engine is backing, the pressure on the guides is in the direction opposite from that when it is going ahead, so this pressure is overcome by what are known as 'backing guides,' which are shown in section C-D. The space back of the 'go-ahead' guide is usually fitted for water circulation, whereby the cold sea water flowing through removes the heat caused by the friction on the rubbing surfaces. Marine engines back so little of the time that it is seldom necessary to fit the 'backing guides' for water circulation.

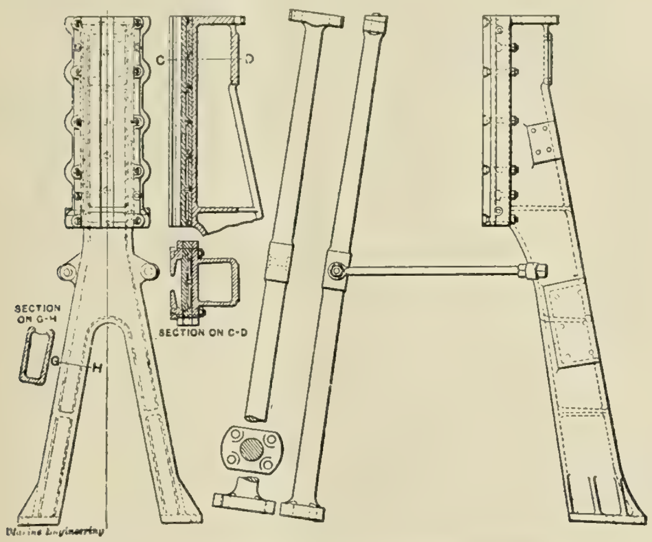


FIG. 6.—INVERTED Y AND CYLINDRICAL COLUMNS

"On our way down the engine we next come to the connecting rod, by means of which the up-and-down or reciprocating motion is transformed into a circular or rotary motion by means of the crank. Perhaps Schmidt can tell us the German name for connecting rod."

"Sure!" said Schmidt. "In the old country they call it the 'verbindungstücken.'"

"Gee!" chimed in O'Rourke, "that's about as long as the rod itself!"

"Yes, the word is rather long, and it means, literally, a binding stick, because it binds or connects the crosshead to the crankpin. These rods are almost invariably forged of mild open-hearth steel. Fig. 7 illustrates the type in most general use.

"The upper end, as you will see, is forked to span the crosshead, each side of the fork being fitted with a bearing and the necessary connections to work on the crosshead pin. Solid brass or bronze is used for the bearing metal, as the pressure is too great to permit of the use of soft, anti-friction metal in the bearings. The lower end of the connecting rod is provided with brasses and a cap or binder, all secured by bolts to the T-shaped end of the connecting rod. These brasses are always fitted with 'Babbitt' or other anti-friction metal to reduce the rubbing friction on the crankpin. The white metal surfaces are scored with oil grooves to allow a proper distribution of the lubricating oil. Bearings, such as crosshead and crankpin brasses, necessarily are subject to wear, and consequently must be provided with means of taking up the lost motion. To that end there are spaces between the top and bottom brasses in which are fitted distance pieces of composition and a varying number of strips of thin sheet brass or tin called 'shims,' which, when removed, take up the lost motion due to the wear on the brasses. Later on I will describe to you the method of adjusting crosshead and connecting rod brasses, which constitutes one of the most important of the many duties which befall the marine engineer.

"The crankshaft is the member that actually turns the propeller, and hence is the connection between the producer and the consumer of the power, or the middleman, as they would tell you in business circles."

"He's the guy that causes the high cost of living; but I never heard him called a crank before," suggested O'Rourke.

"Anyhow, the crankshaft is a very important part of an engine," continued McAndrew. "Nearly all crankshafts are forged of mild open-hearth steel, but some still are built-up forgings of wrought iron. In some high-class marine work the crank for each cylinder is forged in one solid piece, such as shown in Fig. 8.

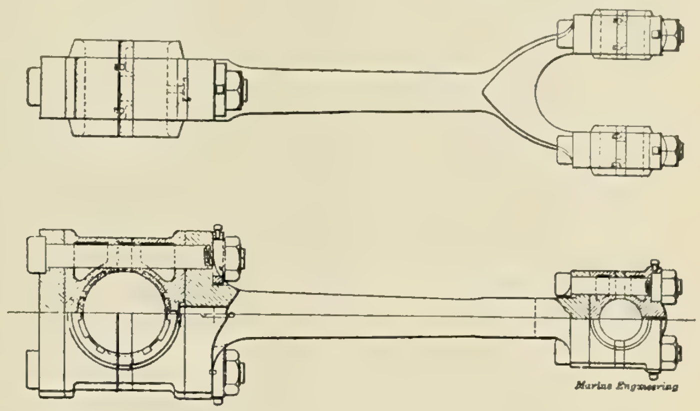


FIG. 7.—CONNECTING ROD

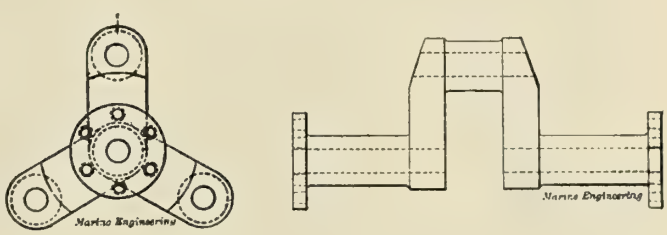


FIG. 8.—SECTION OF FORGED CRANKSHAFT

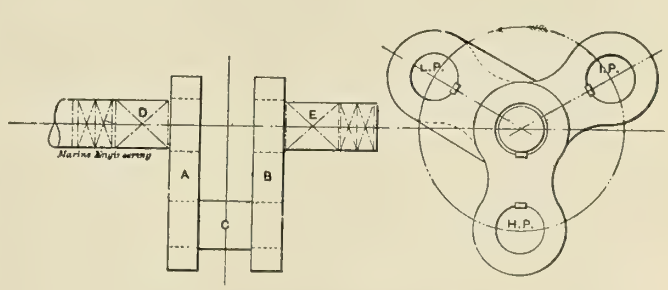


FIG. 9.—SECTION OF BUILT-UP CRANKSHAFT

"The advantage of a crankshaft of this kind is that the sections are interchangeable, so that, for instance, if the low-pressure crankpin should break the high-pressure crank could be put in its place and the engine run compound—that is, if the engine was of the triple-expansion type. The built-up crankshaft is, as its name indicates, composed of several parts, the slabs being shrunk and keyed onto the crank pins and sections of the shaft as shown in Fig. 9."

"Why do some crankshafts have holes in them?" inquired Pierce.

"That is done in high-class work for two principal reasons. One is that it saves weight and the other is that in making large forgings of this kind most of the imperfections, or 'pipes,' as they call them, are liable to be in the central part of the forging. Making the shaft hollow either removes the imperfections or exposes them to the view of the inspector.

"As I told you in the case of the piston rod, a hollow shaft is not stronger than a solid shaft, as many young men imagine; it is simply stronger than a solid shaft containing the same amount of metal. To transmit a twisting strain the metal on the outside of the shaft counts much more than metal at the center. For example, take a shaft 10 inches in diameter; the outer portion of the metal—only .16 inch in thickness—is of as much service in transmitting torsional or twisting strains as the metal 5 inches in diameter at the center of the shaft. Perhaps it will give you a better idea of what I am getting at to state that a shaft 16 inches in diameter, having a 10-inch hole through it, is equal in strength to a solid shaft 15 inches in diameter made of the same kind of metal.

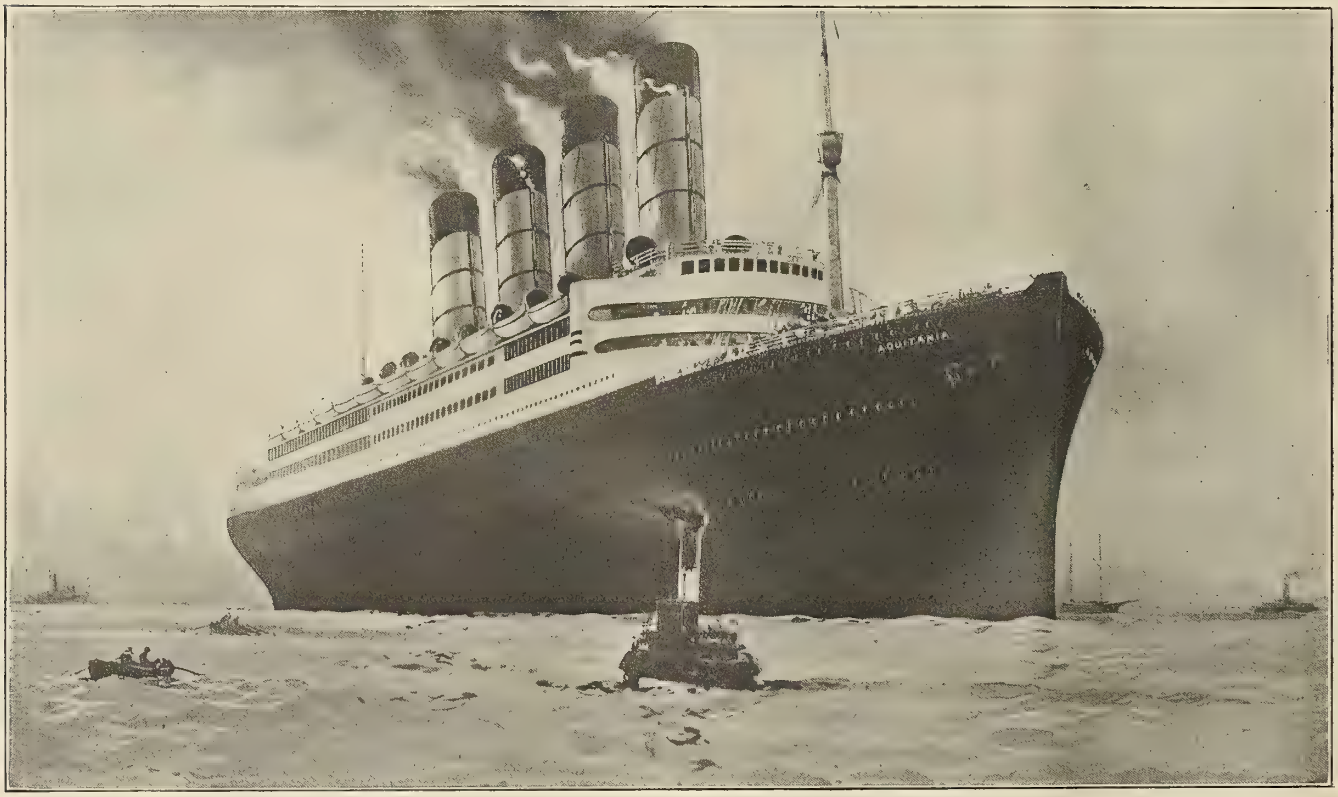
"Further advantages of hollow crank pins are that in case of a pin breaking it could be repaired temporarily by fitting a large bolt through the hole, which would allow the engine to be run slowly at least; the hole through crank pins is also used to advantage in some engines to permit of the fitting of centrifugal oiling devices.

(*To be continued.*)

Lloyds' Shipbuilding Reports.—Lloyds' Shipbuilding Reports, which take into account only the vessels construction of which has actually begun, show that, excluding warships, there were under construction in the United Kingdom at the close of the quarter ended March 31, 1913, 563 vessels of 2,063,694 gross tons. The tonnage now under construction is nearly 94,000 tons more than was in hand at the end of last quarter, and exceeds by 377,000 tons the tonnage building in March a year ago.

Launch of the Aquitania

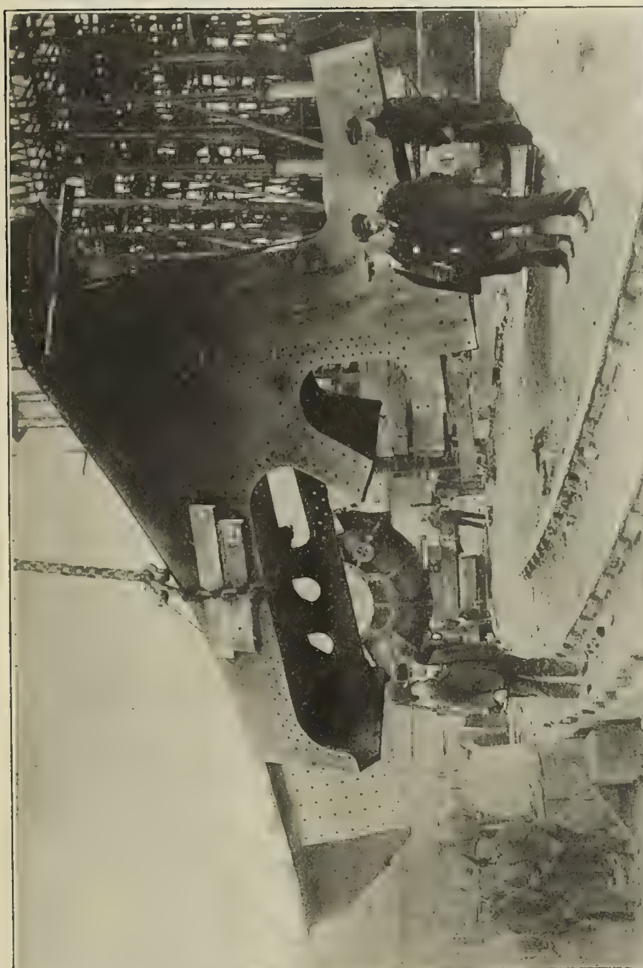
The new Cunard liner *Aquitania,* of 47,000 gross tons, was launched at the Clydebank yards of Messrs. John Brown & Co., Ltd., on April 21. According to information given out by the owners, but unconfirmed by the builders, the ship is 901 feet long, 97 feet beam, with a height from the keel to the boat deck of 92 feet 6 inches. The designed speed is 23 knots. Accommodations will be provided for 3,250 passengers, which with a crew of nearly 1,000, will bring the total number of persons on board to over 4,000. To insure safety, lifeboats capable of accommodating all persons on board are provided, and every effort has been made to make the ship practically unsinkable through the minute subdivision of the hull by both transverse and longitudinal bulkheads. There are 16 transverse bulkheads and throughout the machinery space watertight longitudinal bulkheads, spaced about 15 feet from the outer skin of the ship, are provided, the space thus inclosed being used for coal bunker purposes. According to information disclosed by the owners, the construction of the *Aquitania* conforms very closely to that of the *Lusitania* and *Mauretania,* although she is much larger. As can be seen from the photographs on the opposite page, showing the hull under various stages of construction, the ship is provided with Frahm anti-rolling tanks and watertight decks.



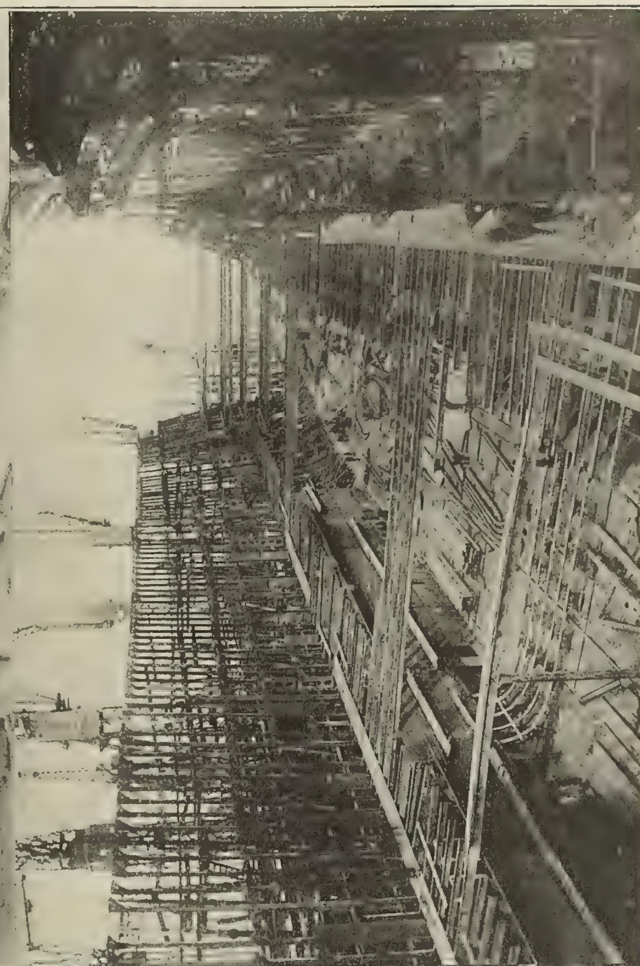
NEW CUNARD LINER AQUITANIA AS SHE WILL LOOK WHEN COMPLETED

The *Aquitania* was constructed on the same berth on which the *Lusitania* was built, but on account of her greater size the berth was enlarged, and for her launching the river was both deepened and widened. The fitting out basin where the ship is now being finished has also been dredged to accommodate the leviathan.

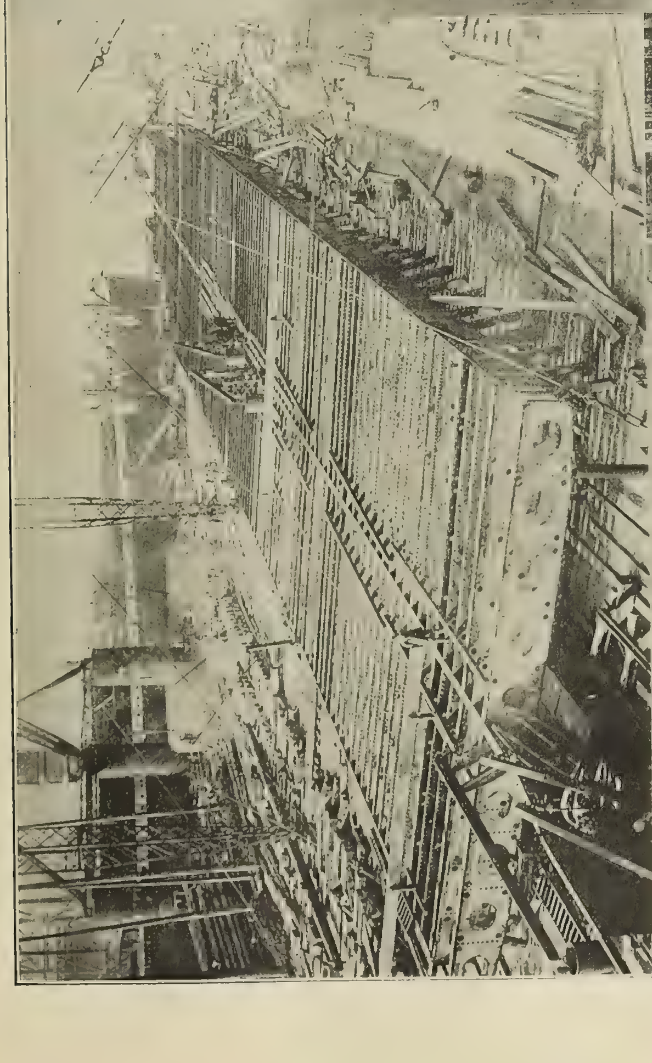
At the present time the Cunard Line has three other ships building, the *Andania* and *Alaunia,* sister ships of 13,000 tons each, which will be used in the Canadian service this summer. These ships accommodate only second and third class passengers. The third Cunarder under construction is the *Transylvania,* which will enter the company's Mediterranean service.



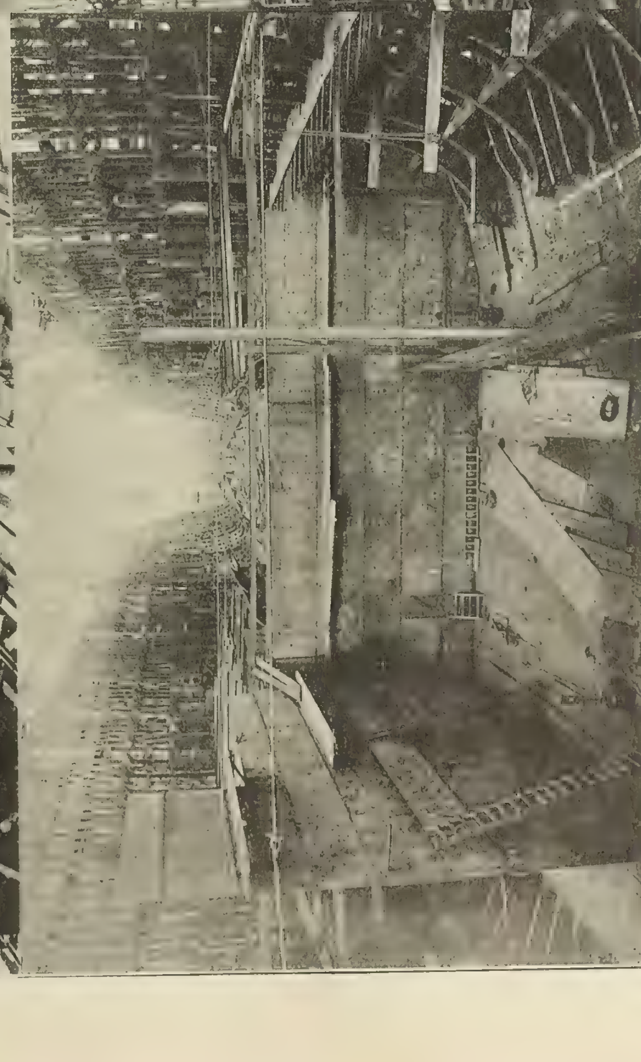
PART OF STERN CASTING WEIGHING 62 TONS



VIEW ABOVE BOILER SPACE LOOKING FORWARD, SHOWING POSITION OF ANTI-ROLLING TANKS



DOUBLE-BOTTOM FRAMING



LOOKING FORWARD FROM THE ENGINE ROOMS, SHOWING BULKHEAD CONSTRUCTION

HAMBURG-AMERICAN 50,000-TON LINER IMPERATOR READY FOR HER MAIDEN VOYAGE

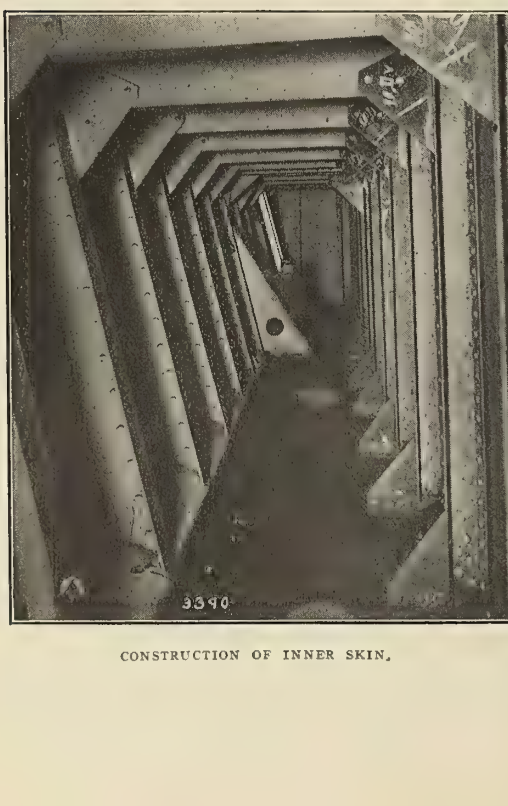
Hamburg-American Liner Imperator

Supplementing the description of the new Hamburg-American liner *Imperator,* which was published in our August, 1912, issue, we print in this issue several interior views of the new vessel, showing the elaborate arrangements for luxurious ocean traveling which have been incorporated in the design.

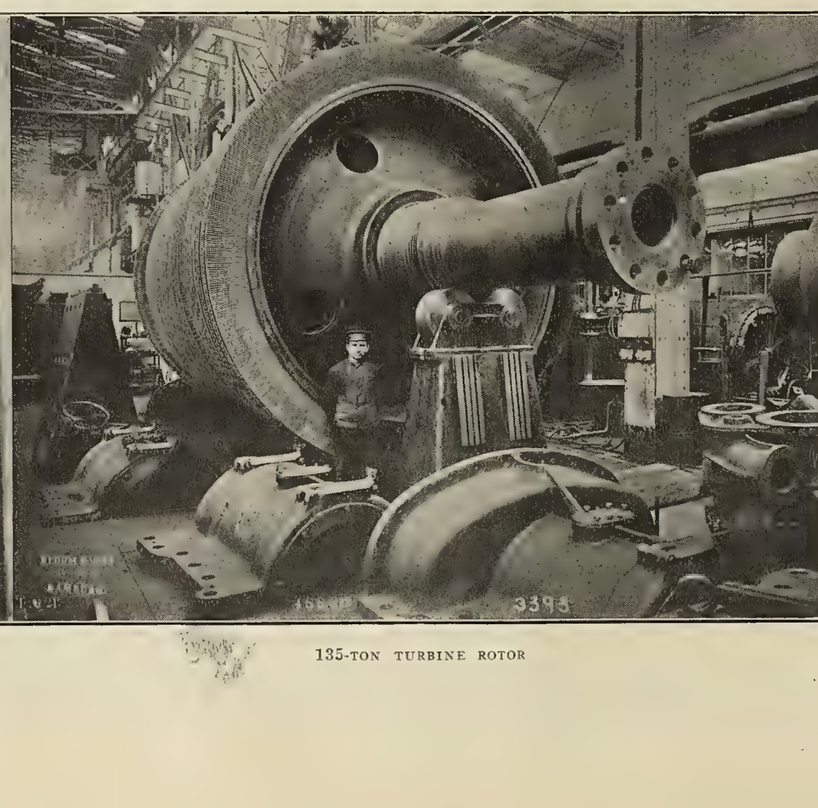
The construction of the *Imperator* was begun in the summer of 1910. She was launched in May, 1912, and will begin her regular service on the 24th of this month. The ship is 919 feet long over all, 879 feet long between perpendiculars, 98 feet beam, 62 feet depth to the uppermost continuous deck, and about 100 feet depth to the boat deck. With a displacement of 70,000 tons and a gross tonnage of 50,000, she is designed for a speed of 22½ knots, power being developed on four shafts by Parsons turbines designed to develop about 72,000 horsepower.

The hull is divided into 36 watertight compartments by means of 12 tranverse bulkheads, and also longitudinal bulkheads and watertight decks. Wing bunkers through the boiler space provide an inner skin, which, together with the double bottom and subdivision of the two engine rooms by longitudinal bulkheads, are designed to protect the ship effectually against disaster from collision, although lifeboats are provided to accommodate all persons on board the ship. Accommodations are provided for 700 first class, 600 second class, 940 third class and 1,750 fourth class passengers. The crew numbers over 1,000.

As can be seen from the illustrations the appointments of the ship involve many unique features. Besides the main dining rooms there are a Ritz-Carlton restaurant, a grill room, tea garden, veranda café, a palm garden, ball room and elaborate gymnasium and baths.



CONSTRUCTION OF INNER SKIN.



135-TON TURBINE ROTOR

SWIMMING POOL
BEDROOM OF PRIVATE SUITE
VERANDA CAFÉ
DRAWING ROOM OF PRIVATE SUITE

GRAND STAIRWAY
PRIVATE DINING ROOM
RITZ-CARLTON RESTAURANT AND WINTER GARDEN

Progress of the Oil Engine in Great Britain

To all appearances the Clyde is going to be the center of Diesel engine building in Britain. Some time ago Messrs. Burmeister & Wain, of Copenhagen, who so successfully engined *Selandia*, the first of the East Asiatic Company's motor liners, bought up the engine works in Glasgow of the London & Glasgow Shipbuilding & Engineering Company, from Messrs. Harland & Wolff, and set down a factory solely for the building of four-cycle Diesel engines, and now a new concern, viz., the North British Diesel Company, have come to the Clyde and are about to lay down a large factory for the building of two-cycle Diesels. There are, of course, some eight or nine firms on the Clyde who hold licenses for the building of Continental Diesels, and three of these firms are at present working on Diesel contracts, but the fact that before very long there will be two factories on the Clyde entirely devoted to the building of the high compression internal combustion engine is sufficient to show that the west of Scotland intends to retain its prominent position in the engineering world.

Of late we have read a lot about the number of Diesel engines building in Germany, Holland, Switzerland and other parts of the Continent, and after all not too much about what is going on in Britain. Accordingly, it will be of interest to many to know that there are building on the Clyde alone at the present moment no fewer than eighteen marine Diesel engines, all more or less of high power. Five of these engines are four-cycle Burmeister & Wain six-cylinder sets of 1,600 indicated horsepower each. Four are engines of 1,125 indicated horsepower each, while four others are six-cylinder 600 indicated horsepower sets intended as cruising machinery for two Japanese destroyers building by Messrs. Yarrow & Co., Ltd., Glasgow.

Messrs. Burmeister & Wain, it should be said, have equipped their Glasgow factory with machinery capable of turning out cylinders up to 40-inch bore. A cylinder of this diameter gives approximately 900 indicated horsepower, so that a six-cylinder engine could be built to give 5,400 indicated horsepower. Three such engines in a triple screw ship would mean a total horsepower of over 16,000, or well over that of the 550-foot to 600-foot 17-knot passenger liner. Whether we shall see Diesel engines in favor for powers above this or not time will tell, but these figures, I think, are sufficient to show that the Clyde is in a position to supply first-class liners with internal combustion machinery.

Early in March there was launched by Messrs Wm. Chalmers & Co., Rutherglen, the 400-ton deadweight carrying motor coaster *Innisshannon*, the eighth vessel of the type for the Coasting Motor Shipping Company, Glasgow. She is the second highest powered semi-Diesel ship in the world (the 350 brake horsepower Bolinders engined vessel *Isleford*, recently completed on the Clyde, being the highest), and much the highest powered British engined semi-Diesel vessel yet launched. She is 115 feet in length between perpendiculars, by 21 feet 6 inches beam by 10 feet 6 inches molded depth, and will carry her full cargo on a draft of 9 feet 6 inches. The engines take the form of a four-cylinder Beardmore solid injection hot bulb set of 220 brake-horsepower, the cylinders being 14 inches diameter by 14½-inch stroke, and the speed of the engine 280 revolutions per minute. The engine is direct reversible, reversing being carried out by compressed air on full load, and no clutch of any kind is fitted to the propeller shaft.

A special feature about this engine is that there is no water drip service fitted. Messrs. Wm. Beardmore & Co. have now given up fitting the water drip to these higher powered semi-Diesels, having so perfected the design that there is little or no gain in efficiency or saving in fuel by using water. Fuel to the extent of about 2,800 gallons will be carried in four tanks arranged in the engine room. On trials fully loaded a speed of 8 to 8½ knots is expected. I hope, however, in an early issue of International Marne Engineering, to publish drawings of this vessel's hull and machinery, with a description of this interesting Beardmore engine, which, by the way, has only just been put on the market.

The Coasting Motor Shipping Company, Glasgow, took delivery recently from Messrs. Peter MacGregor & Sons, Kirkintilloch, of a 150-ton deadweight carrying coaster named the *Inniseane*. The vessel is 67 feet in length by 18 feet 3 inches beam by 9 feet 6 inches molded depth, and has been built to pass through the locks on the Forth and Clyde Canal. Her load draft on open water is 8 feet 6 inches, but on the Canal this will be restricted to 8 feet 3 inches, and the carrying capacity to 135 tons. Her engines consist of a two-cylinder 90 brake horsepower Kromhout semi-Diesel set driving a four-bladed propeller through a reverse gear. About 1,200 gallons of fuel, or sufficient for three weeks' running, is carried in two tanks in the engine room.

Owing to the great demand for semi-Diesel engines for small commercial vessels, manufacturers of these motors are now putting higher powered sets on the market and giving some attention to improvements in design. Recently Messrs. Plenty & Sons, Newbury, the manufacturers of the British Kromhout motor put on the market through their selling agents, Messrs. Perman & Co., London, a new 130 brake horsepower two-cylinder set which promises to meet with favor for commercial boats. One or two rather noteworthy features have been embodied in the design of this engine, not the least of these being light vertical columns to the cylinder heads, which have the effect of taking the thrust off the bolts connecting the cylinder to the upper chamber. The arrangement is somewhat similar to that followed in the well-known Werkspoor four-cycle Diesel, which hails from Holland.

Again the Tuxham semi-Diesel, a Continental production and an engine now meeting with favor in Britain, is, I understand, to be turned out in sizes of 120 brake horsepower and upwards on the open crankpit model. There will be no scavenging valves, scavenging air being obtained by stepping the pistons after the lines of the M. A. N. and F. I. A. T. Diesels. The open crankpit is, of course, common in pure Diesel engines of the two-stroke cycle variety, but so far it has not been taken up seriously by builders of the low compression hot bulb engine. The advantage lies in great accessibility, it being possible at all times to watch the lubrication of the bottom ends.

It is intimated that we may also expect to see something new from the Bolinders Works in Stockholm. The Bolinders engine, as most of us know, reverses on the pre-ignition principal. Nothing as yet has been allowed to leak out regarding this, but it is quite probable that it will take the form of an air-reversing engine.

It will be of interest to many to know that the new motor coaster *Isleford*, formerly owned by Messrs. Mann, MacNeil & Co., Glasgow, and which ran trials in February, has been sold to the British Government. Hot Bulb.

Launch of the Socony.—Constructed to meet the requirements in Panama Canal trade the oil tank ship *Socony*, the last of a fleet of four steamers built for the Standard Oil Company, New York, was launched this month at the yards of the New York Shipbuilding Company, Camden, N. J. The *Socony* is a bulk oil carrier of 30,000 barrels capacity, 330 feet long, 46 beam and 26 feet deep.

Letters from Practical Marine Engineers

Incidents Relating to the Design, Care and Handling of Marine Engines, Boilers and Auxiliaries; Breakdowns at Sea and Repairs

Below Decks on the Official Trial Trip of a Cruiser

The word had been passed around the yard in the morning by the foremen to the men selected as engine and fire-room crew for the trial trip of the new cruiser to report at the "shanty," the headquarters of the foreman of erection work, at 1.45 P. M.

Promptly at the time set about 200 men gathered there, speculating as to the positions that would be assigned them. A spectator could see at a glance that this was indeed a picked crew. Keen intelligence, indomitable courage, showed in every face. In a few minutes the foreman of erection work appeared with a paper in his hand, from which he read the names and the station assigned to each man. He and the shop foreman were to be chief engineers, the ship foremen or quartermen were to be assistant engineers, and licensed men in nearly every case were to serve as oilers, water tenders and blower engine men. Firemen had been gathered for weeks previous, every fireman who applied at the yard for a job being put to work as a helper, cleaning around and polishing bright work just to hold them, the work that they did previous to the trial trip not amounting to much in the way of profit to the company.

When the names had been read off the men were ordered to report aboard the ship at 7 A. M. on the morning of the trial trip, and then were sent back to their work. Every man felt proud of the fact that he was considered competent enough to be selected for this trip; besides, each man knew he would receive a bonus in addition to the overtime made on the trip.

At the appointed time all hands reported aboard the ship to the assistant engineer under whom he was detailed; this done, he looked up the sleeping berth to which he was assigned. The quarters were not very commodious, simply tiers of temporary bunks on the berth deck, in each of which was a straw mattress and pillow that had seen service several times before, and a horse blanket for covering. But who cared for that! The honor conferred was sufficient to make up for the hardships.

A separate detail of men, under the charge of the night engineer, had been aboard all night, and had steam on the eight double-end eight-furnace boilers. The first watch went below, and soon the three triple expansion engines were turning over. An assistant engineer and four oilers were detailed to each set of engines, with an additional oiler for the pumps in each engine room and one for each shaft alley; one assistant engineer was stationed in the fire rooms, with a water tender to every two boilers, one man to each blower engine, four firemen and two coal passers in each of the eight fire rooms, in each of the two watches, together with the machinists, electricians, blacksmiths, boilermakers, coppersmiths, and other mechanics, all of which constituted the "black squad."

At about 9 A. M. the lines were cast off and the long-looked-for trip began. The tension that everyone, from members of the firm down to coal passers, was under was apparent in the set expression of faces. This was in the days of premium for excess over the contract speed, each quarter knot that this ship exceeded the contract speed meaning $50,000 (£10,275) to the builders, and each man realized that he had some part in earning this.

At noontime the first meal was served. And what a feed! Uncle Sam paid the expenses of the official trips in those days, and expense did not cut much of a figure on that trip. Fish, flesh and fowl, with all the trimmings, desserts of all kinds, even fruit and ice cream, made up the bill of fare. No wonder the doctor's services were in such constant demand. Stomachs that had never before been called on to digest anything but ordinary food were now overloaded with lobster, shrimp, salads of all kinds, and other indigestible food, and a six-hour watch in the fire room was more than enough to bring on an attack of cramps. The wonder is that some one didn't die.

The word was passed to the oilers not to spare oil. They didn't. To an engineer accustomed to economizing as much as possible the apparent waste was appalling. Squirt cans were used only for oiling the pumps. In addition to the automatic oilers on every journal, hand oiling was done with a two-quart feeder that had a half-inch opening in the spout. Guides and piston rods were lubricated by the use of syringes. A hot journal meant expense to the builders; oil cost them nothing, being included in the cost of the trip. The oilers were supplied with a full suit of oilskins from the store room, and even with these on they were soon soaked to the skin. The vertical engines were necessarily very short-connected in order to get the cylinders below the protective deck, and this made it hard on the crosshead journals. A spray pipe, led up from the water service on each side of the crossheads, was kept playing on almost all of these journals, and the result can be imagined by any engineer. Every half hour or so the floor plates were washed down with a stream of water from a hose attached to the donkey pump, in order that the men could keep their footing.

After an uneventful run the ship anchored in the evening in Boston harbor, and the night watch took charge, giving the regular watches a chance to get a good night's rest.

Two days were spent in preparing for the run that was to be made over the official course off the coast of Maine. Journals that had not worked well on the run around to Boston were stripped, and where necessary smoothed up and readjusted. The crosshead journals in particular required attention; in some cases the brasses were found broken and were replaced with spare ones that were carried; almost all of the crosshead pins had cut some and had to be trued up by hand. Fires were hauled, furnaces and back connections cleaned out and scrubbed with wire brushes, and the tubes were swept. Every bolt and nut that could possibly work loose was gone over and tightened, and everything that could prevent a successful run was looked after in those two days.

The morning of the run dawned bright and fair, and the nervous strain was more apparent than ever in every man's face. The second watch was to take the ship out to the starting line, and then the first watch, who were the picked men of a picked crew, was to make the run, the second watch to bring the ship back to the anchorage.

About fifteen minutes before the starting line was reached the first watch came on. The speed had gradually been increased until the ship was then almost up to top speed. The second watch was ordered to stand by on deck for emergencies. A water tender was stationed at each stop valve on deck, where the valve stems came through, so that in case of accident they could be promptly closed. As the ship crossed the line the whistle sounded a long blast and the race was on. A race? Yes, a race against time and for money, and no race between Mississippi River steamboats in the old days was ever more exciting.

Naval officers were taking indicator cards from every cylinder, including all auxiliaries, every fifteen minutes, together with other data, such as gage pressures, coal consumption, ashes, water level in boilers, air pressure in fire rooms, etc.

Rumors of all kinds, wholly unreliable, were passed fore and aft through the engine and fire rooms. Intense indeed was the excitement below decks. There was some excitement, of course, on deck, but the men below knew that they were the factors that made success or failure. All that was required of the deck crew was to steer a straight course, and this required no great skill or effort. In about two hours the whistle sounded again, indicating that the end of the course had been reached and the first half of the run completed. As the ship heeled when the wheel was put hard over to turn around for the last half of the run, there was a perceptible relaxation of nerves. One half of the run had been completed and everything was in good shape.

The run back over the course was a repetition of the first half, except that the excitement was, if possible, more intense. Would she keep it up? Everyone knew that if the speed attained during the first half could be maintained success was assured. The boilers had steamed well and the engines had stood up finely, and unless some blunder had been made in the designing the contract speed would surely be exceeded.

Again the whistle sounded as the finish line was crossed. The blowers were slowed, the main engines eased up, air-tight doors in the fire rooms were opened, and the second watch rushed below. The excitement over, the inevitable reaction came—the men who had made the run were in a pitiable condition, indeed almost everyone was in a state bordering on collapse. But they had the satisfaction of knowing that they had done their duty. They had done all that it was possible for men to do to make the run successful and profitable for their employers, and men could do no more.

The ship was run back to the anchorage under reduced speed. While on the way back the speed made on the official run was calculated and found to be a fraction over 23 knots, this being 2 knots over the contract, insuring a premium of $200,000 (£41,100) for the builders. The speed attained in knots was painted in large figures on both sides of one of the smokestacks, thus proudly proclaiming another success for the firm.

After a good night's rest the run home was begun the next morning. On the passage all manner of experiments were made to obtain data. Sometimes the two forward engines would be stopped, only the after one being used; then the two forward ones would be used, the after one being stopped. At different times two, four and six of the boilers would be cut out, the others being used under forced and natural draft, revolutions, speed of ship by log, coal consumption, and other data being taken for future calculations.

The run to the builder's yard was made without untoward event, and a tired but happy lot of men filed down the gangplank on arrival there. Everyone felt that never again would this ship make as good speed as had been made through their efforts. All were rewarded by the firm by the payment of a bonus to each of from $15 (£3.08) to $100 (£20.6), varying according to the responsibilities of the position they had filled. J. S.

Sale of the Fore River Shipbuilding Company.—The Fore River Shipbuilding Company, Quincy, Mass., has been sold to the Bethlehem Steel Company, and hereafter will be operated as a department of the steel company.

English Ship Draftsmen and Technical Graduates

During the past year, while the writer was in England, he visited a number of shipyards, and part of the time was actually employed in the drawing office. In this way he was thrown among English draftsmen and technical graduates and had an opportunity to study their condition and compare them with men in like positions in the United States. As the average ship draftsman in America is rather dissatisfied and the technical graduate starting in believes he is rather badly treated, the condition under which these men work in England should be of interest.

To begin with, we must take the draftsman as he starts in and understand the conditions that surround him. The average English boy leaves school between fourteen and sixteen, unless he intends to go to college, and there are very few of them that do this, as well be seen later. Upon leaving school the boy is apprenticed to some trade until he becomes twenty-one. Thus a lad of fifteen, with a common grammar school education, starts in to become a draftsman. At first he acts as office boy, but later is advanced to assist in blue printing, and finally towards the end of his apprenticeship he is allowed to do a little drawing. As far as I could learn no effort is made to help him or teach him, but he is simply left to his own resources. At the end of his apprenticeship he generally leaves and takes up a position with some other firm where he can make a start, for, as a rule, after his apprenticeship is over his employers offer him little inducement.

Briefly, these are the conditions under which a draftsman begins. This apprenticeship exists to some extent in various forms in the United States, but in England it is universal. In seeking employment in a new firm the first question asked is, "Where did you serve your apprenticeship?" If the applicant has not served one there is no place open to him.

A draftsman's work is practically the same in England as in America, although I think a little more responsibility is thrown upon him, for, as will be known later, a greater portion of the calculation work falls upon him. The hours of work are practically the same in both countries, varying, of course, in different yards. Perhaps the Englishman has a little the advantage, for I believe the average is nearer seven and one-half hours than eight. Regarding vacations, he is much better off, for all the older men get two weeks in summer with pay and the young men one week. Then there are always from three days to a week at Christmas and sometimes at Easter, but there are very few scattered holidays such as there are in the United States. In other respects there is hardly any comparison.

The pay of the English draftsman is very small, the average man getting from $10 to $12 (£2 1s. 8d. to £2 10s.) a week. The maximum pay is $17 to $18 (£3 10s. 10d. to £3 15s.). On the Clyde the pay is smaller and $15 (£3 2s. 6d.) is generally the top limit. One man I met while with a noted English firm had been with the sompany eight years and was drawing $17 (£3 10s. 10d.) a week—the highest paid man in the office. This man, who was about thirty-five, was married and had two children. When work was slack in the office he was always in fear of losing his position, for it is the general policy to let the high paid men go and get cheaper and younger men when new work comes in. This case is typical of many others I might cite, for most of the men are married and struggling to maintain a home and bring up a family on from $12 to $18 (£2 10s. to £3 15s.) a week. To be sure, the price of living is less than in America, but the difference is much smaller than people believe. I have lived with these men in a shipyard town and know by experience that the living expenses are nearly the same. They live on their earnings because they must, but they have a much lower standard of living than American draftsmen.

To save money is absolutely impossible. One man getting

$17.50 (£3 12s. 11d.) a week told me he had saved only $10 (£2 1s. 8d.) in three years! To be sure, all this might be passed over if there was something better ahead, but there is not. When the draftsman's pay reaches $18 (£3 15s.) he has nothing whatever ahead of him. Of course some of them are advanced to chiefs, but very few, and even then, from what I have seen, the chief draftsman's position is little better.

The draftsman's hope is that some day he may find some new kind of work, perhaps in the Colonies. Many of them are looking to America, hoping some day to come here, where the draftsman has better opportunities and better pay. Some of them find openings in the various societies, such as Lloyds and the Board of Trade, but with a hundred applications for one position, as was the case this year, there is very little hope in that direction. An incident came to my notice that is worthy of mention. An advertisement appeared in one of the engineering papers wanting one ship draftsman in Australia. Over three hundred men on the Clyde alone answered this advertisement.

As regards ability and training from my observation, I believe that man for man they surpass the American draftsmen. The greater part of the men understand the various hull calculations, such as displacement, stability, strength, etc. Beyond the exact steps to follow in making the calculations, they of course know little, nor have they any conception of the finer problems of naval architecture, such as power and speed, distribution of displacement, etc. Very few American draftsmen, barring the technical graduates, are as familiar with calculations and none, I believe, would be found able to carry through stress calculations of a ship among waves. This condition is brought about by the English system of evening schools. Every shipyard town has its classes in naval architecture, and nearly all the apprentices attend these classes, some of them for seven or eight years. While this is a rather unsatisfactory education, yet, coupled with the daily practical work, it makes a good all-round man for the drawing office.

Perhaps the reader may ask why men go into drafting if such conditions exist? Simply because there is nothing else to do. England is overcrowded, and every man must fight, and fight hard, for his living. There are ten men looking for every place, and every place of any value is quickly filled by some friend or relative of the directors or management. Of course the men are dissatisfied, but there is nothing to do but submit. Shipbuilding presents as good an opening as anything, for it must be remembered that these same conditions exist in all lines of industry. In 1907, during the depression in shipbuilding, many of the draftsmen were forced to work in the yards as laborers.

The following incident shows exactly what these men are up against. In one office I came to work in the morning to find the thermometer at 38 degrees and all the men at work with overcoats and gloves. This condition existed day after day, and from the chief down they all were too afraid of losing their place if they complained to the management. Some offices treat their men much better; some give them a bonus at Christmas, but these are exceptions. None give any better pay, and always the raises are small, sometimes as low as 60 cents (2s. 6d.); a dollar (4s. 2d) is considered a good raise. Having thus seen briefly the condition of the ship draftsman, let us turn to the technical graduate, for his condition is much worse.

In a recent article in International Marine Engineering, Prof. Everett pointed out the handicap of the technical graduate in America. It is true that the technical graduate has a hard fight for a start in naval architecture in the United States, but much of this I believe is due to the poor condition of American shipbuilding. In England, however, he has absolutely no opening at all, either in naval architecture or any other engineering profession.

In American shipyards most of the technical and calculating work is done by the technical graduate. All the yards appreciate the value of the men in this capacity, and it gives the graduate an opening where he can make himself valuable to his employers and at the same time learn the practical end that is being carried on about him. Some of the graduates, however, enter the drawing office, of course at small pay, but they are given a chance and most of them make good. There are a few men also who start in by working in the yard for a short time, but there are very few who do this. The American technical graduate upon starting in generally gets from $15 to $20 (£3 2s. 6d. to £4 3s. 4d.) a week for office work, and this is a good living salary—at least, for a few years.

In England, however, his condition is totally different. A technical education there is practically four years thrown away or, as one graduate told me, worse than suicide. There is in England a class of men whose fathers are shipbuilders or men of influence in this line. These men are educated in Glasgow or some other technical college, and upon graduation step into good positions with a bright future before them. The average man, however, without influence or money, has a totally different outlook. He leaves college and is wanted by no one—in fact, with hardly an exception every shipyard will refuse him a position. With this state of affairs staring him in the face, he has two alternatives: either he must start in as an apprentice and serve two or three years under the same conditions as other apprentices, or buy his way into some firm as a pupil. There is a way of paying a considerable sum for an apprenticeship. Men that do this are called premium apprentices, and as far as I could learn the only difference between the regular and premium apprentices is that the latter pay a large sum and are given less attention.

The pupilage is really the better, if one can afford it, for the pupil is given opportunities to work in the various departments of the yard. He thus spends four or five years as a laborer in the yard, working the same hours as the other laborers. These pupils so called are taught nothing whatever, but left to their own resources, merely being transferred from one department to another. Several pupils and premium apprentices with whom I was acquainted while there knew less about actual shop work at the end of their terms than the graduates from the best American technical schools. Of course it all depends upon the man, but once the premium is paid the company does no more, and very few of the fellow workers give them any attention. At the end of the yard and shop term the pupil is transferred to the drawing room, only to find that he is not wanted and the chief is prejudiced against him.

One man I knew who was a Master of Science from one of the leading English engineering colleges was a premium apprentice in one of the leading shipyards, having paid a large sum or premium to the company. This man was seldom given any work to do, yet he wasn't allowed to leave the particular building in which he was placed. While I was with this company this man spent most of his time cleaning and repairing his bicycle!

As another illustration, there was another man with this company as a pupil who paid $1,000 (£206) for his pupilage. This man, who had been with the company four years, had passed through the various departments and was in the drawing office. He also was a Master of Science from one of the leading universities and was practically a draftsman, but his salary was only $2.50 (10s. 5d.) a week! Certainly a bright state of affairs after eight years of training.

These are only two of the many cases that I might mention, but they are typical of them all. Both of these were smart, clever men, but had never been given a fighting chance. As I mentioned before the pupilage and premium apprenticeship are only open to those who can afford it, as the cost varies from $500 to $1,500 (£103 to £309). It surely isn't a bright outlook for a man who has spent four years at hard study to spend four more in the yard, only to graduate as a draftsman in the end. In four years of this kind of work one becomes very rusty in technical work and must lose all enthusiasm and all ambition for his profession.

In some yards the graduate is given a little better chance. Then, too, many work summers in the yards and become acquainted with the practical side during their college course, but in the end they are little better off. Taking it all through as far as it came to my notice, the technical graduate is much worse off than the non-technical draftsman and receives very little consideration from the shipyards. These conditions are not only to be found in shipbuilding but in all branches of engineering.

How can we account for this state of affairs? Simply that the English are a practical people, throwing all the emphasis on the art and none on the science of engineering. Much sooner would a yard promote one of their own trained apprentices to a responsible position than bring in a new man technically trained in naval architecture. One firm where I was employed had a chief draftsman in the merchant department who had never worked in any other yard, and everything was carried on as it had been for the last thirty years. In my opinion this policy, which is more or less universal in England, of failing to introduce new blood, is causing the ruin of some companies.

As I mentioned before, the draftsmen are well instructed in the evening schools, which are lacking in America, and are capable of doing a great deal of the calculation work. This may account somewhat for the treatment of the technical graduate. In the past these evening schools have turned out some very capable engineers, but can England keep up this same out-of-date policy in this age of science and competition? Engineering science has developed enormously in the last few years, and it is no longer possible to get training in these evening classes anywhere near equal to the technical colleges.

The condition of the draftsman, as I have shown, is caused by the overcrowded condition of England, but the status of the technical graduate is caused by employers themselves.

Thus, while Germany and America are creating a large corps of technically trained men and giving them every encouragement, England is training her men by the old evening school method and not even giving the technical graduate a chance to make good. Many of the English graduates in engineering are coming to America, where they are given a fair start, and of course many of them never return.

In the past England has held the lead in shipbuilding and still holds it far beyond any other nation, but can she keep up this policy and hold the lead? Truly it is a problem worthy of great thought, but one not to be treated here.

My aim has been merely to point out the deplorable condition in England of the young naval architect without influence and without money. It appears to be only a profession for men of wealth and influence and not open to everyone, as in America. L. B. Chapman.

Action of Rust

Water in the presence of iron decomposes, its oxygen combining with the iron forming oxide of iron, or rust. Its hydrogen is set free at the rate of about 44 cubic inches for each grain of rust developed. Rust occupies about twice the volume of the iron contained in it, and it absorbs from 18 to 28 percent by weight of moisture, so this moisture, if rust is not stopped, will attack other parts of the metal and form more rust. Rust once developed, if not cleaned off thoroughly before painting, will continue to develop under the paint. It will develop very fast under poor paint, but only slowly under good paint. Rust thus developed will gradually force the paint away from the metal and cause it to crack or peel off. The best way to overcome this action is to clean the metal as thoroughly as possible and then paint it with a good graphite paint. A Brother Engineer.

Motor Ship Monte Penedo

It appears that all sorts of rumors have been in circulation during the last few weeks regarding the motor ship *Monte Penedo,* mainly to the effect that the vessel has met with an accident and generally has not given satisfaction. As this is contrary to the truth, we take the opportunity to set forth herewith an account of the true state of affairs and of the results obtained up-to-date.

The vessel sailed from Hamburg on August 31, from Lisbon on Sept. 6, and arrived in Paranagua, Brazil, on Sept. 26 after a non-stop run, reporting "All in good order." From Paranagua the vessel sailed to Buenos Ayres, where the engines were overhauled and when cracks were found in several pistons. As a doubt existed regarding the advisability of allowing the vessel to proceed to the various loading ports in Platte and to return to Europe, we decided to take no unnecessary risks, and therefore replaced all pistons by others of improved design. Otherwise the engines were in excellent condition and the engineers reported that not one bearing ran warm throughout the whole voyage. The vessel sailed for the loading ports immediately the alteration was completed, and in due course left Rosario on the homeward voyage. On March 1 we received a telegram from Hamburg that the vessel had arrived, that the machinery was in excellent condition, and that during the thirty days' voyage the engines had worked splendidly and given every satisfaction. The average fuel consumption per twenty-four hours for all purposes amounted to 7,200 kilogrammes, or 151 grammes per indicated horsepower hour, the consumption of lubricating oil including auxiliaries, steering engine, etc., being 2.8 grammes per indicated horsepower hour. The engines were then subjected to a thorough inspection, and it was found that all internal surfaces, and especially the pistons, were clean and bright, showing that throughout the entire voyage the combustion had been perfect. All parts were carefully gaged without showing the slightest appreciable wear and tear.

It can therefore be readily seen that apart from the trouble we have had with the pistons, the replacing of which, as we have pointed out, was more a matter of precaution than absolute necessity, very satisfactory results have been obtained. We feel that when we say that, as absolutely no repairs were necessary, the Hamburg-Sud immediately billed the outward sailing for March 20, no further remarks on our part are necessary.

It is also of interest, however, that during heavy weather in the Bay the governors worked splendidly. In contrast to the racing steam engines and the attendant noise, it was only by observing the tachometer (which showed a maximum increase of from 10 to 12 revolutions per minute) that one knew the propellers were out of water. The pure air in all parts of the ship, and especially down below, was specially remarked upon by the crew. Gebrüder Sulzer.

Shipbuilding in the United States.—The Bureau of Navigation reports 1,114 sailing, steam and unrigged vessels of 260,265 gross tons built in the United States and officially numbered during the nine months ended March 31, 1913. During the corresponding nine months ended March 31, 1912, 1,051 sailing, steam and unrigged vessels of 151,241 gross tons were built in the United States and officially numbered.

Marine Articles in the Engineering Press

Steering Men-of-War by Electricity.—By Ensign W. A. Edwards, U. S. N. The U. S. S. *Chester* and the U. S. S. *Des Moines* are the only two ships of the United States navy which are equipped with the Cutler Hammer system of electric steering. The successful results obtained with this gear seem to indicate that other installations will soon appear in future ships, and the author gives with some detail his experiences in the operation of the gear, as a guide for those who may in some future time have occasion to use it. 4 illustrations. 5,500 words.—*United States Naval Institute Proceedings*, March.

The Passenger and Cargo Steamer Fauvette.—The *Fauvette* is a single-screw steamer owned by the General Steam Navigation Company, Ltd., London, and engaged in the London and Bordeaux service of that company. The vessel was built by Sir Raylton Dixon & Company, Ltd., of Middlesbrough, and is 315 feet long between perpendiculars, 43 feet 9 inches beam molded, 21 feet depth molded to upper deck. There are two continuous steel decks—the shelter and upper decks, respectively—extending over the length of the ship. Besides the double bottom, subdivision is further effected by five transverse watertight bulkheads. Accommodation is provided for 106 first class passengers, while a few second class passengers are provided for in an after-deck house. Electric power is used extensively for driving the deck machinery, which is very complete, and includes special cranes for the rapid handling of freight. The propelling machinery, built by the North Eastern Marine Engineering Company, Ltd., consists of a set of triple-expansion reciprocating engines of 3,300 indicated horsepower, for which steam is supplied by three large single-ended boilers. On trials a speed of 15.34 knots was obtained. 6 illustrations. 1,000 words.—*The Shipbuilder*, April.

The Weight Factor in Merchant Ship Design.—By T. C. Tobin, M. A. (Cantab.), M. I. N. A. There are three main ways in which the weight factor has to be considered in order to deal fully with the problem whose solution is the finished ship. The first of these involves the determination of the quantity and distribution chiefly in the vertical and longitudinal direction of the material forming the main structure so that it may have the necessary strength and rigidity to withstand all the stresses likely to be brought upon it. The second way in which the weight affects the design is in the vertical distribution of the total weight involved, determining, as it does, the vertical position of the center of gravity, one of the twin points affecting the stability of the ship The third way in which the weight factor makes itself felt is that, from a commercial point of view, the weights must be treated as mere weights to be handled under given conditions. It is to the consideration of this third phase of the weight factor as affecting the design of merchant vessels that this paper was prepared for presentation before the Liverpool Engineering Society, and the subject is exhaustively treated. 4,000 words. —*The Steamship*, April.

The Story of the Pacific Line.—The Pacific Steam Navigation Company was organized in 1840, and two paddle-wheel steamers, the *Chile* and *Peru*, 198 feet long, 50 feet beam, of 700 tons and 150 horsepower, were built and placed in service between Panama and Valparaiso. From this beginning the company's business continually grew. Affiliations were made with other steamship companies, mainly with the Royal Mail Steam Packet Company, which only recently formed a combination of the two companies, to be further strengthened by the addition of the Lamport & Holt Line. With the growth of the company the equipment has, of course, shown corresponding development. At the end of the eighties the company added to its fleet such vessels as the *Oruba* of 5,971 tons. In 1895 the twin-screw type of steamer was adopted, and has been adhered to, so that at the present time the company owns no fewer than eighteen twin-screw steamers. The largest steamer of the present fleet is the *Orcoma*, of 11,533 tons gross register, built in 1908 by Messrs. Beardmore. A large building programme is now on hand, the company having adopted the combination of high-pressure reciprocating engines driving two wing screws with a central propeller driven by a low-pressure turbine. Six vessels of this type are to be built, four of which will be of 15,000 tons each. The present total tonnage of ships building and built under the company's flag is put at 243,003 tons gross register. The article is an interesting account of the growth of this company, and is well illustrated by pictures of the earliest and latest of the company's vessels. 7 illustrations. 3,000 words.—*Marine Engineer and Naval Architect*, April.

Launch of the Andrea Doria.—The fifth Italian dreadnought, *Andrea Doria*, was launched at the Spezia Arsenal March 30. The new vessel, laid down March 24, 1912, is 554.5 feet long between perpendiculars, 91.86 feet extreme beam, 22,700 tons normal displacement, 28¾ feet normal draft. The propelling machinery consists of Parsons turbines aggregating 28,000 horsepower, divided into three groups in three separate compartments supplied with steam by twenty watertube Blechynden boilers, half of which are fitted for liquid fuel and half for "mixed combustion." The designed speed is 22½ knots. The main armament consists of thirteen 12-inch guns, arranged in five armored turrets, besides eighteen 3-inch guns and four torpedo tubes. The main armor belt is 10 inches thick, reduced to 8½ and 5½ inches at the ends. 4 illustrations. 850 words.—*The Engineer*, April 11.

The Emanuel Nobel.—The *Emanuel Nobel*, which is the second ship to be fitted with the new design of Werkspoor motors, was built by the Nederland Shipbuilding Company, of Amsterdam, for the Société Anonyme d'Armament, d'Industrie et de Commerce, of Antwerp. The ship is 390 feet 6 inches long by 51 feet molded beam and 21 feet molded depth. On 23 feet draft she displaces 9,560 tons, thus ranking as one of the largest motor ships afloat. On trial she attained a speed of 11.4 knots when loaded to her specified draft, which is nearly one-half a knot in excess of her contract speed. There are two sets of engines, with cylinders 22½ inches diameter by 40 inches stroke, which have a combined indicated horsepower of 2,850 at 180 revolutions per minute. All auxiliaries are steam driven. 3 illustrations. 980 words.—*The Engineer*, March 28.

New Coal Handling Plant at Fort William, Ontario.—The Canadian Pacific Railway recently put into operation at Fort William, Ontario, an extensive plant for handling coal from lake steamers, which is in several ways a radical departure from the usual method of handling by means of grab buckets. This plant is equipped with Hulett unloaders of the same general type as the unloading machines which are commonly used in handling ore at lake ports, and is the first installation of Hulett equipment for the purpose. The total length of the dock is approximately 3,000 feet, although the available water frontage or dock space is limited to about 600 feet, or the length of the largest coal ships. The two unloading machines, built by the Wellman-Seaver-Morgan Company, of Cleveland, Ohio, are operated by electricity. 4 illustrations. 1,500 words. —*Railway and Engineering Review*, February 8.

The Weight of Marine Oil Engines.—The actual weights of marine oil engines, in spite of the many dissimilarities in design and the different types which are built, show no very marked variation for the same power. As a rough estimate, taking the usual slow-speed type of Diesel engine, it may be considered that the weight, including the accessories for the engine itself, is somewhere in the neighborhood of 200 pounds per brake-horsepower. Taken over a range of a large number of engines it has been found that the figures vary between 180 pounds and about 230 pounds per brake-horsepower, and are, of course, dependent largely upon the speed of revolution. The figures given are mainly for engines running between 110 and 140 or 150 revolutions per minute, and with the probable forthcoming adoption of speeds of 100 revolutions per minute and under, the weight would be slightly in excess of these figures. 1,800 words.—*The Motor Ship and Motor Boat*, February 20.

Shipbuilding Berth Gantries at the Nagasaki Yard.—Following a brief account of the history of the establishment of the various shipyards in Japan, attention is called to the first gantry to be erected in a private shipyard in Japan. This gantry, constructed from the designs of Sir William Arrol & Company, Ltd., of Glasgow, by the Mitsu-Bishi Company, Nagasaki, is designed for a double berth, although as yet only one berth has been erected. The length is 790 feet with a clear width between towers of 116 feet and a total height from the berth to the top of the structure of 186 feet at the water end. The main towers are spaced 92½ feet between centers longitudinally. The crane equipment in each berth consists of one 30-ton crane on the lower crane track, four 5-ton cranes and two 10-ton cranes on the upper crane track. The lower crane track is placed at a level of 114 feet above the floor of the berth at the water end, and the upper crane track is at a level of 138 feet. The 30-ton crane spans the full width of the berth, the smaller cranes span from the side to the center of the berth. Two illustrations. 1,350 words.—*Engineering*, February 14.

The Launch of the New York.—By Naval Constructor Robert Stocker, U. S. N., and Naval Constructor Henry Williams, U. S. N. Although it is generally recognized that a man-of-war is usually more difficult to launch than a merchant ship of equal or even greater displacement, because the weights are concentrated over a shorter length and because it is of greater beam, and even though the structure is more complicated, its local strength and ability to withstand the concentrated loads incident to launching are less than is the case with a merchant ship, nevertheless the various problems involved in the launching are not fully realized except by the naval constructors and the shipbuilders who have had similar work in hand. This article gives a very complete description of the launching of the *New York*, discussing in detail the various problems entering into the procedure. Such matters as the building slip, the launching ways, the method of release, the lubricant, the fore and after poppets and packing and internal shoring, are taken up in detail and well illustrated by drawings and photographs. Curves are given of the launching data and calculations of various forces and moments acting, and also showing data taken during the launching used in determining the coefficient of friction of the sliding surfaces from which a curve of coefficient of friction is deduced. 14 illustrations. 8,500 words.—*United States Naval Institute Proceedings*, December.

The Unsinkability of Modern Sea-going Ships.—By Geheimer Regierungstrat Professor Flamm, Charlottenburg. Two courses have hitherto been taken in order to find the limits for spacing bulkheads in merchant ships or to determine whether the arrangement of bulkheads adopted in a design is justifiable or not. One course is that of laying down hard-and-fast rules for the spacing of bulkheads admissible in passenger steamers. These rules have been framed on the model of those suggested by the British Bulkhead Committee of 1890, but they do not take into account the question of stability. The other course is that of establishing by individual calculation the floating power and the stability of the vessels when compartments of critical dimensions are assumed to be open to the sea. In the first case different percentages of deductions, evenly distributed over the whole space of the engine and boiler rooms, cargo holds and end compartments, are prescribed, whereas in the second instance these percentages are examined individually as to their amount and their situation within the damaged compartment. The author proceeds to discuss the question of which of these two methods of treatment is the most appropriate one, and to determine how far one may proceed in the first direction and at what point the second must be begun. As a result of his investigations he concludes that a careful determination of the stability in a damaged condition of large modern ships is required, and should be carried out for each particular vessel. He also points out, upon a consideration of the facts, that the watertight subdivisions of these ships, if it is based on the existing bulkhead curves, is worthless. Moreover, the bulkhead curve only regulates the spacing of transverse bulkheads; longitudinal bulkheads are not included. He holds that in any proposed regulations for the unsinkability of ships, that is, on the arrangement of bulkheads, this calculation should be compulsory. If not, the regulations are incomplete, and no public department can take upon itself the responsibility for the proper subdivisions of vessels not built according to rules improved in this direction. 12 illustrations. 2,700 words.—*Engineering*, February 14.

The Williams-Janney Variable Speed Gear.—Many attempts have been made to produce an efficient and compact infinitely variable hydraulic speed gear, but in nearly all cases difficulties are found in preventing leakage of the working fluid from the active system and providing for the taking up of wear in the working parts, and also in devising a method of control easy to operate and positive in its action. In the Williams-Janney gear leakage from the active system has been reduced to an amount only sufficient for lubricating the working parts; any wear that may take place is taken up automatically, but, owing to the film of oil maintained between the working parts theoretically there is no wear and the control, by means of which the speed is varied, can be easily operated by hand even in machines transmitting several hundred horsepower. The first Williams-Janney gear was brought out in 1907, but since then it has been effectually improved and is now being widely adopted by the United States and other navies for the control of the gun-training gear and a great variety of other uses in industrial applications where for any periods a variation in speed is required. The gear consists of two similar hydraulic units, each of which comprises a group of cylinders mounted on a shaft revolving in a fixed casing, one unit fulfilling the function of a pump and supplying fluid to the other, which acts as a motor. The pump is driven at a constant speed in one direction from the source of power, and means are provided whereby the stroke of its pistons may be varied, with a consequent result that the rate at which the fluid is delivered can be adjusted as desired from zero to the full capacity of the pump. The motor unit, however, has a fixed stroke, so that its speed will depend upon the quantity of fluid delivered by the pump. The change from one speed to another is effected without any steps whatsoever, while in passing from the forward to reverse direction on the motor the pump passes through the position of no-stroke, and thus the change is made without any shock. 14 illustrations. 2,000 words.—*Engineering*, Jan. 31.

New Books for the Marine Engineer's Library

Boiler Explosions in England

BOILER EXPLOSIONS, COLLAPSES AND MISHAPS. By E. J. Rimmer. Size, 5½ by 8½ inches. Pages, 135. New York, 1912: D. Van Nostrand Company, and London, 1912: Constable & Company, Ltd. Price, $1.75 net, and 4s. 6d. net.

Whenever boiler explosions are the subject of comment in the daily or technical press attention is invariably called to the fact that England, in spite of her immense industrial activities, is practically immune from disastrous boiler explosions. In fact, England is frequently held up as a model in this respect, although little is said about the laws and statutes that bring about this much-to-be desired state of affairs. It is doubtful if many boiler makers or engineers in the United States have a very clear idea of what these laws are, or how they are enforced. As a matter of fact England is by no means immune from boiler explosions, but each explosion that occurs, whether in a railway, marine or stationary boiler plant, is thoroughly investigated, and every possible means is utilized to establish beyond a doubt the actual cause of the explosion. The knowledge gained by such thorough investigations serves as both a warning and a guide for further construction, operation and inspection of steam boilers, and tends to raise the standard of safety to the highest level. All legislation in England in regard to boilers and boiler explosions is contained in the following statutes: Boiler Explosions Acts, 1882 and 1890; Factory and Workshop Acts, 1901; Railway Regulation Act, 1871; Metalliferous Mines Regulation Act, 1872; Coal Mines Act, 1911; Quarry Act, 1894; Merchant Shipping Act, 1894; Notice of Accidents Acts, 1894 and 1906; Railway Employment (prevention of accidents) Act, 1900. The most important statutes affecting all steam users are the first of the above named; that is, the Boiler Explosions Acts, 1882 and 1890. In this volume the author has endeavored to bring together the results of all the inquiries and investigations made under these two acts. There have been over 2,000 of these inquiries, and though each in turn has been the subject of comment by various authorities in the engineering press, it is very likely that the lessons which they teach have been forgotten or else have never been brought to the notice of the general body of steam users. Placing before the reader in this small volume the gist of all these inquiries, logically arranged and appropriately classified, so that the lessons which they teach as to the cause and prevention of boiler explosions may be thoroughly understood, is a task for which the author deserves great credit. The book is divided into four sections, as follows: Legislation in Regard to Boilers and Boiler Explosions; Formal Investigations and Findings of Commissioners as to Negligence; The Cause and Prevention of Explosions and Evidence of Causes and Explosions. The book has been ably prepared, and should prove of great value to boiler makers and boiler users.

LESSONS IN MECHANICS FOR MARINE ENGINEERS AND ENGINEERING STUDENTS. By A. N. Somerscales. Size, 4½ by 7¼ inches. Pages, 276. Illustrations, 149. Glasgow, 1912: James Munro & Company, Ltd. Price, 3s. 6d. net.

The lessons given in this book were originally prepared for evening classes of students at the Hull Young People's Institute under the Technical Instruction Committee. In this institute most of the students are obliged to get an intelligent knowledge of the principles of mechanics without a previous training in algebraic and trigonometrical reasoning. For this reason the lessons are taught with a purely arithmetical treatment. The book is, therefore, essentially an elementary book. All of the subject matter and the examples and exercises given in connection with each chapter have been prepared with especial regard for the requirements of the marine engineer.

The Elements of Machine Design

REVIEWED BY PROF. C. H. PEABODY*

THE ELEMENTS OF MACHINE DESIGN. Part II. Chiefly on engine details. By W. Cawthorne Unwin, F. R. S., LL. D., and A. L. Mellanby, D. Sc. Size, 5½ by 8½ inches. Pages, 426. Illustrations, 311. New York and London, 1912: Longmans, Green & Company. Price, $2.50 (7s. 6d.) net.

About thirty years ago there appeared in the series of Textbooks of Science a modest book on machine design by Professor Unwin, a man who was then and is now one of the leaders in technical education. By 1890 the book, in the eleventh edition, had grown to two volumes, and now appears this new and enlarged edition, the number of which is not stated.

From the first the work has been characterized by a judicious combination of sound theory and practical application. In the preface of this edition is the following advice to students: "It is in the nature of the case that, in school instruction and in textbooks for students, theoretical considerations occupy relatively a larger space than in ordinary routine of the drawing office. The experienced designer of machinery has no need to recur constantly to first principles, although no doubt he has systematized his experience by the aid of all the science he possesses. The inexperienced student, much as he will be assisted by theory in dealing with practical problems, will no doubt be liable to misapply it; for a knowledge of the limits within which theory can be trusted—or, more accurately, a knowledge of the extent to which a theory covers the data in any given case—is only arrived at gradually. Meanwhile he is likely to meet rebuffs which seem to imply that theory is held in very low esteem by practical engineers." Good doctrine this, and as applicable to American students as to English; but though the preface offers to the student an answer to rebuffs, it is not needed here, for if rebuffs are met the American may well digest them as he may if he has no answer of his own.

Some of the anxiety to be practical passes over from the preface into the body of the book, as in the treatment of rectangular plates on page 58, of combined indicator diagrams on page 81, and graphical representation of the dynamics of the piston and connecting rod on page 115; but this is largely a matter of discretion where the authors have as much right, if not more, than a reviewer.

In a book so full of good material it is a little difficult to select parts for special mention, but to the reviewer the following appealed most forcibly: The recommendation to use moderate steam pressure (180 pounds); the use of simultaneous equations for investigating diagrams of compound engines; the testing of spring-ring piston packing; the computation of stress due to slatting of connecting rods; the method of proportioning cranks, cross heads and connecting rods of stationary and locomotive engines, and the treatment of strength of fly-wheels.

The book is full of excellent drawings of parts and details of engine, etc.; but they are poorly executed. We should charge this to the publisher of an American book, because our engravers will give a good finish to any sketch; in any case this defect in such a book is much to be regretted.

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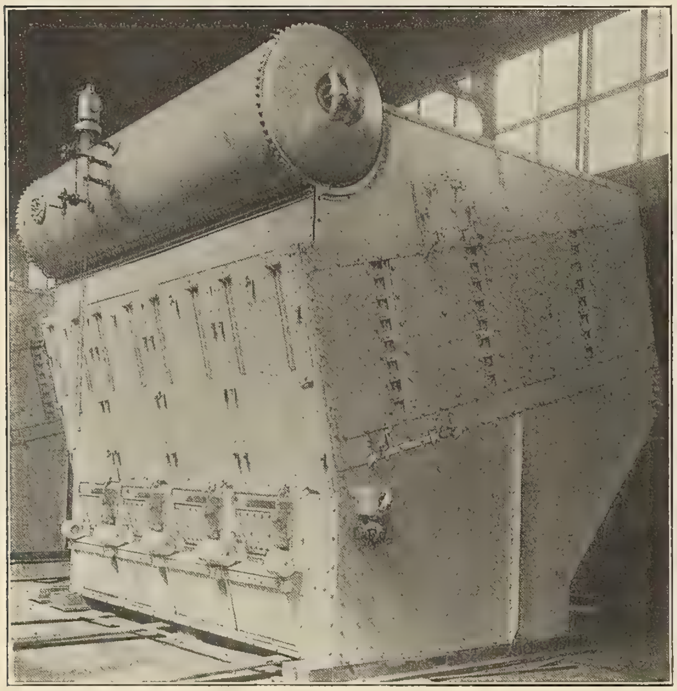
ENGINEERING SPECIALTIES

Babcock & Wilcox Dredge Type Boiler

The Babcock & Wilcox Company, New York, manufacture a standard dredge type boiler which has been applied successfully to many dredge installations, including large ocean-going dredges and floating dry docks. This boiler, since it is of the watertube type, and therefore combines the features of accessibility, safety, quick steaming and efficiency, was designed to take the place of the Scotch boiler, and is an actual marine boiler built in accordance with the requirements of the Supervising Inspectors of Steam Vessels. The boiler is built entirely of forged open hearth steel, no cast or malleable iron



being used under pressure. The tubes are all seamless steel tubes and like the Scotch boiler the boiler contains only straight tubes and expanded joints. This boiler, while considerably heavier and occupying more space than the well-known Babcock & Wilcox battleship type, still embodies the salient features of that widely used design. The large furnace volume secured by the upwardly sloping tubes covered by the reverberatory roof-baffle of firebrick and the special baffle arrangement directing the gases three times across the tubes, combine to give good efficiency and capacity even with indifferent firing. The dredge type of the Babcock & Wilcox boiler, illustrated herewith, was built for the United States army dredge *New Orleans,* now operating at the mouth of the Mississippi River.

"Imperial" Riveting Hammers Nos. 60 and 80

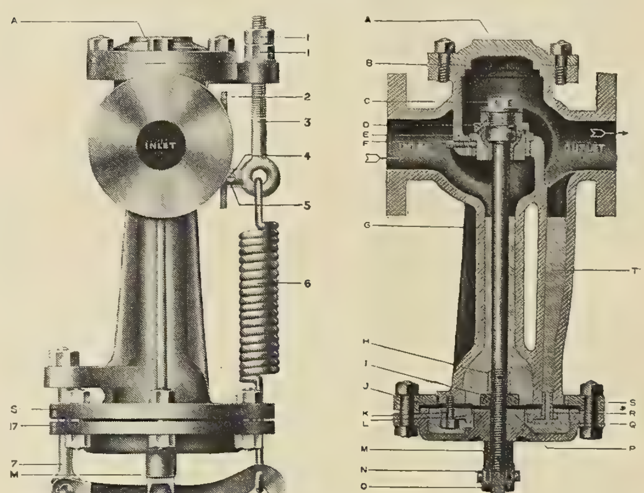
An improved pneumatic riveting hammer which has some novel features was brought out recently by the Ingersoll-Rand Company, New York. As will be seen from the illustration, the valve chamber is independent of the piston chamber, which permits the use of pistons of different lengths without the liability of valve breakages so common in pneumatic hammers where the piston travels through the valve or where the construction is such that the valve travels in line with the piston and is shifted by the piston compression. The grip handle is liberal in size, is improved with a single lever throttle with long bearing, and the handle is attached to the cylinder by means of two bolts which are parallel to the cylinder on the sides. This, it is claimed, insures perfect locking of the handle to the cylinder and precludes the necessity of a vise or other mechanical device for holding the tool in taking apart or assembling. This feature is especially convenient to the structural iron workers who are not always equipped with the proper facilities for repairing tools. The hammer can be taken apart on the floor or the bench, and the only appliance necessary is a wrench for removing the nuts on the bolts.

There is only one large port down the cylinder, equal in volume to the usual multiple port construction, but eliminating the liability of clogging, frequent in the older designs.

The hammer is short in length, light in weight and easy to handle; it has a very sensitive throttle control, making it specially suitable for drift pin work. The hammer is made in two sizes—No. 60, with a 6-inch stroke and capacity for driving rivets up to 7/8-inch in diameter, and No. 80, with an 8-inch stroke suitable for driving rivets up to 1 1/4 inches in diameter. The cylinder and handle are drop forged and all wearing parts are hardened. Another important feature is the sand blast finish on both the cylinder and handle, which overcomes the hand slippages so frequent with hammers of polished construction.

Auld "Quitetite" Reducing Valve

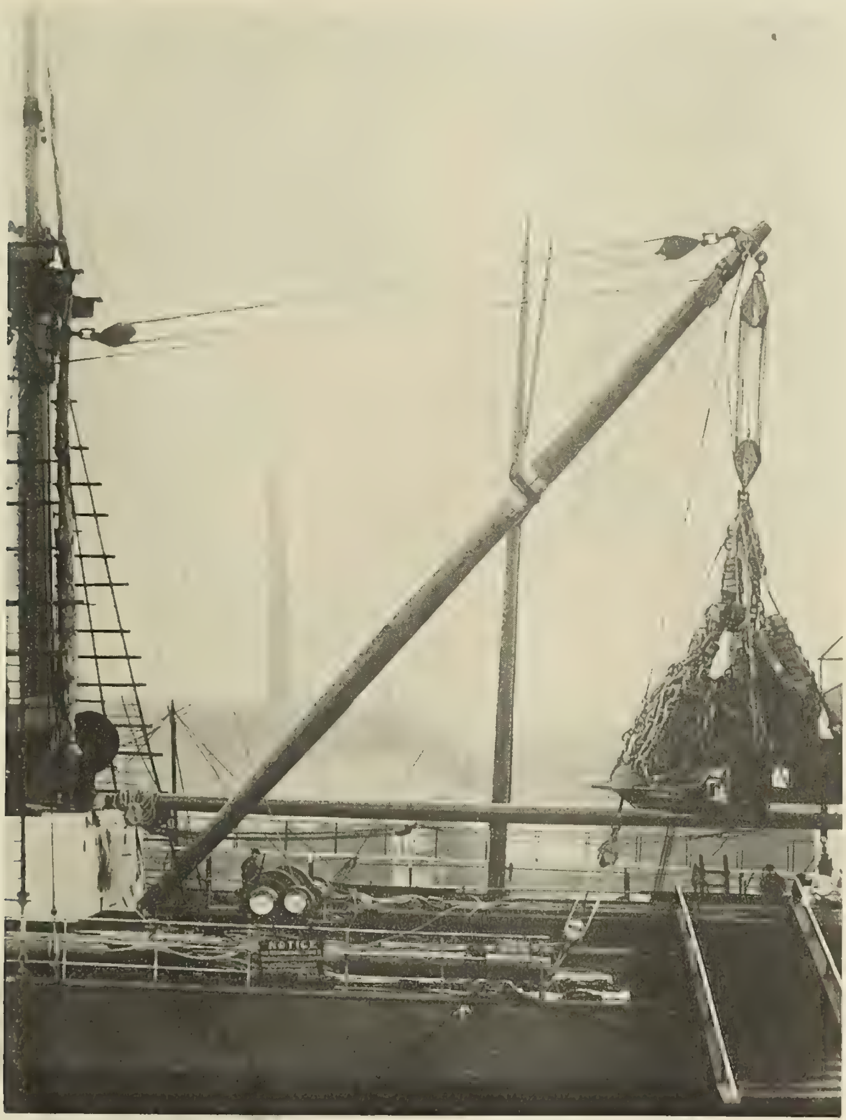
The Auld "Quitetite" reducing valve illustrated, which is manufactured in Scotland by David Auld & Sons Company, Ltd., of Glasgow, and in the United States by Schutte & Koerting Company, Philadelphia, Pa., is a useful boiler accessory for cases where it is desired to use reduced pressure steam. The valves are specially designed for accurately reducing from any high pressure down to any lower pressure



which may be desired, so that they will hold this reduced pressure constant irrespective of fluctuations on the initial or boiler side, and also when no steam is being used on the outlet side of the valve. With these valves it is claimed that it is quite possible to maintain a constant reduced pressure of two or three pounds on the outlet side, while the boiler pressure may be as high as 250 pounds per square inch. There are two branches, one on each side of the valve, one of which is the inlet and the other the outlet. High-pressure steam enters through the inlet and acts between valve (*D*) at the top and piston (*P*) at the bottom, which are the same area, and, therefore, in equilibrium on the high-pressure side. Reduced pressure is obtained by screwing up adjusting nuts (1) on the spring bolt (3) until the pointer on the spring bolt is opposite the figure on the scale representing the reduced pressure required. Acting through the lever (o), at the bottom of the valve, the expansion of spring (6) opens up the valve between the inlet and outlet branches, and passes steam at a reduced pressure to the outlet side. When the pressure of this reduced steam tends to rise above that required it closes the valve by acting on the back of valve (*D*) and chamber (*Q*). When the pressure tends to fall, the tension of spring (6) overcomes the force holding the valve clased, and thereby opens the valve, allowing it to admit more steam to the low-pressure side, and in this way the reduced pressure is kept constant. A flexible diaphragm is fitted at the lower end of the valve body, which, it is claimed, makes a frictionless steam-tight packing between the stationary and movable lower parts of the valve. This diaphragm is protected from the action of steam by water of condensation which collects in the lower part of the valve and keeps the diaphragm cool. The valve is manufactured in all sizes, from one-half inch upward.

Steel Tubular Derrick

The illustration shows a 55-foot steel tubular derrick lifting a test load of 42½ tons at Messrs. Sir W. G. Armstrong Whitworth & Co.'s Elswick yard. The derrick was supplied by Messrs. The British Mannesmann Tube Company, Ltd., of Salisbury House, London, E. C. This firm manufactures all kinds of tubular masts, derricks, deck pillars, boat's davits, defense booms, etc., all of which up to 12 inches diameter are made of weldless steel tubing, and over this size of lapwelded tubing. The derricks are designed to carry any load up to and over 40 tons, and the davits up to and over 10 tons. Masts, derricks and defense booms are made in many lengths, and of course have many advantages over the solid articles, the most important being that they are much lighter for a given strength.



Burbridge Double Davits

R. Lickey & Company, Glasgow, has placed on the market a special type of boat davits so constructed that two boats can be carried in the same deck space as is now occupied by one, and, when ready for use, every part is securely inboard. The construction of the davits is simple, consisting of an ordinary ship's davit with a smaller one attached to it by means of two heavy forged collars; thus ordinary davits can be altered without any structural alterations to the ship. The boats are stored one above the other. The upper boat is always suspended ready for immediate launching, but before

putting it outboard the small davits are swung around to the outboard position and a locking pin inserted. The movement of the upper boat when swung outboard will thus bring the small davits inboard over the lower boat, and the attachment

of this lower boat to the smaller davits is carried out while the upper boat is being lowered into the water. Immediately the upper boat is safely launched and the tackles free, the main davits are pulled inboard, so that the lower boat is carried safely outboard and then launched. Whenever possible the centers of the davits should coincide with the centers of the suspension points of the boats, otherwise the locking pin-holes must be altered from their designed position.

Allen Dredger Buckets

The illustration shows a group of dredger buckets with cast steel backs which are equipped with Allen's imperial manganese steel lips and bushes. These buckets are manufactured by Edgar Allen & Co., Ltd., Imperial Steel Works, Tinsley,

Sheffield. As can be seen from the illustration, the bucket lips are renewable. Other parts of dredging apparatus, which are subject to heavy wear, are also made of Allen's imperial manganese steel, on account of its strength and lasting qualities.

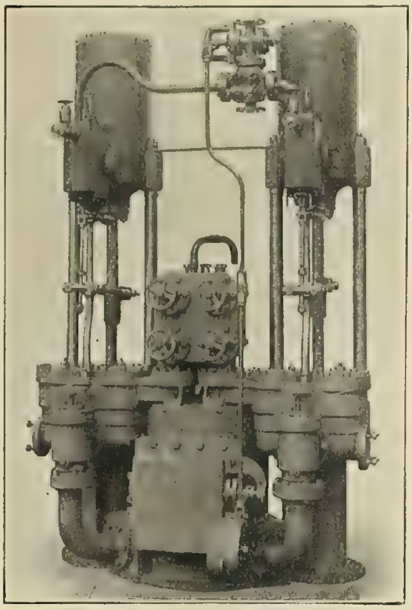
Motor Pumping Plant

The illustration shows a 12-horsepower motor pumping plant, manufactured by J. W. Brooke & Company, Ltd., Lowestoft, in which an 11-inch diameter centrifugal pump, capable of handling 1,300 gallons of water per minute against an 18-foot head, is mounted on a cast iron base, together with a Brooke

gasoline (petrol) engine of 12 horsepower. The engine operates at 1,000 revolutions per minute, and is connected to the pump by 2 to 1 spur machine-cut gearing, driving the pump at 500 revolutions per minute. This type of motor pumping plant is manufactured in sizes from 3 horsepower up to 50 horsepower, both portable and stationary, and is especially useful for emergency work where inaccessible places must be reached.

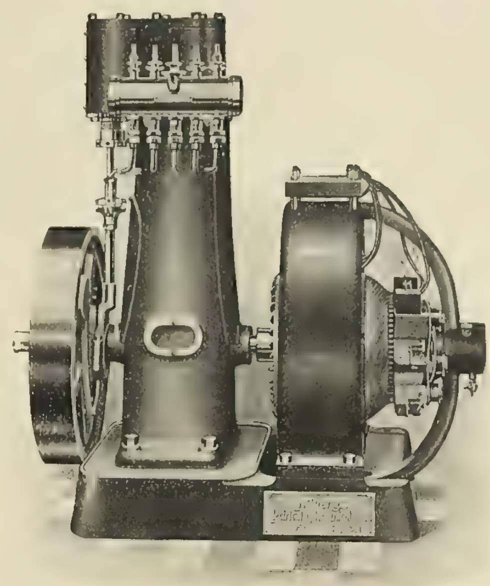
Hall Boiler Feed Pumps

The illustration shows a pair of boiler feed pumps built by J. H. Hall & Sons, Ltd., Peterborough, for the Port of London Authorities for installation on their dredging vessels. Sixteen sets of these pumps were supplied for this purpose. Economy of operation is as important in dredge operations as in other work involving the use of large power plants. No small item in the economy of a steam plant is the performance of the boiler feed pumps, and in the Hall pumps special attention has been given in the design to reduce the consumption of steam to a minimum. This is accomplished by means of a cut-off in the steam cylinder capable of variation to the required duties. The steam chest on these pumps is formed in two separate chambers, the larger containing the main valve, which is steam driven, and the smaller the auxiliary or impulse valve, which is mechanically driven by means of levers from the motion of the piston rod. The valve is open to steam at both ends, so that all the work put upon the gear is simply to lift the weight of this valve. The impulse valve has two functions: It admits steam at the end of each stroke to the main-valve chamber to drive this valve and, at the same time, it serves to cut off steam to the cylinder. This cut-off, together with the special system of cushioning of both steam valve and piston, makes the running of the Hall pump very smooth and steady.



Engberg's Direct-Connected Generating Sets

The Engberg's Electric & Mechanical Works, St. Joseph, Mich., have on the market direct-connected generating sets ranging from 2½ to 50 kilowatts capacity, which are particularly adapted for use on dredges. The sets comprise a vertical type engine and a multipolar generator compound-wound both mounted on the same base, and arranged for accessibility and ease of adjustment of all working parts. The valve of the engine is of the balanced piston type. A flywheel so designed as to retain the greater part of the weight up close to the main bearing of the engine frame is fitted. The governor, which is simple and effective, controlling the speed within 2 percent from low to full load, is of the manufacturer's own design. On all of these generating sets larger than 2½ kilowatts a special lubricating system is installed, made up of an oil pump situated in the base of the engine, pumping the oil from an oil reservoir up into a sight-feed oil cup, which leads to a distributing oil trough on the inside of the engine framing. From here oil pipes lead to all movable bearings, which are grooved to insure proper distribution of oil. The 2½ kilowatt set, which is illustrated, receives lubrication from a conveniently located sight-feed multiple oiler. The generators are of the multipolar type compound wound for 110 volts, unless otherwise specified. The armature is of the iron-clad ventilated type, with laminated core, built of electrical sheet steel, thoroughly japanned before assembling, the drum and core provided with air ducts permitting a thorough circulation of air through the same. The engine crank coupling is coupled direct to the armature drum.



Personal

Charles S. Linch, marine engineer and naval architect, has opened an office at 33 Broadway, New York city.

Robert A. C. Smith, chairman of the New York State Harbor Commission, has been appointed Dock Commissioner of the Port of New York, succeeding Calvin Tomkins, whose resignation took effect April 2.

George Hills, formerly manager of the welding department of the C & C Electric Manufacturing Company, Garwood, N. J., is now associated with the Electric Welding Materials Company, New York City.

Obituary

Phillip H. Diehl, electrical engineer and inventor, and founder of the Diehl Manufacturing Company, Elizabeth, N. J., died at his home in Elizabeth, April 7.

Commander Walter J. Sears, U. S. N., who has been in charge of the Municipal Ferry Service of New York City since his retirement from the navy in 1907, died at the Naval Hospital, Brooklyn, March 29, in his fifty-sixth year.

Edmund Haynes Haswell, well known as a steamship man, and at one time head of the Pacific Mail Steamship Company, died in New Rochelle, April 3, at the age of eighty.

William H. Fletcher, vice-president of the W. & A. Fletcher Company, Hoboken, N. J., died at his home in New York City on April 2 at the age of fifty-six. Mr. Fletcher was one of the best-known marine engineers and shipbuilders in the United States.

George William Quintard, president of the Quintard Iron Works, New York, died April 2 in New York City at the age of ninety. Throughout his life Mr. Quintard was prominently identified with engine building, shipbuilding and steamship interests in the United States.

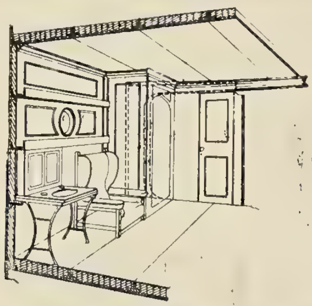
SELECTED MARINE PATENTS

The publication in this column of a patent specification does not necessarily imply editorial commendation.

American patents compiled by Delbert H. Decker, Esq., registered patent attorney, Loan & Trust Building, Washington, D. C.

1,052,060. CONSTRUCTION OF STATEROOMS. JOSEPH W. ISHERWOOD, OF MIDDLESBROUGH, ENGLAND.

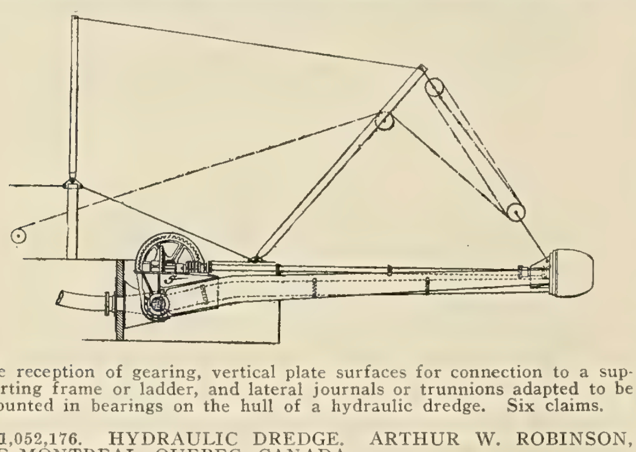
Claim 1.—In a ship provided with transverse frames and beams; side and deck plating secured directly to said frames and beams respectively; a partition coinciding with one of said transverse frames and beams; and



a longitudinal beam located above the free space inclosed by said partition, and located above said deck plating thereby leaving the said inclosed free space unobstructed by said longitudinal beam. Three claims.

1,052,148. HYDRAULIC DREDGE. THOMAS JARDINE, OF PATERSON, N. J.

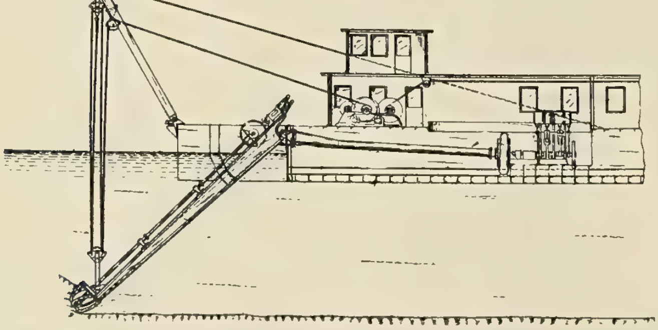
Claim 5.—A trunnion head for hydraulic dredges, comprising, in a unitary structure, a bed plate to receive separated shaft bearings, downwardly depending oil reservoirs made integral with said bearings for



the reception of gearing, vertical plate surfaces for connection to a supporting frame or ladder, and lateral journals or trunnions adapted to be mounted in bearings on the hull of a hydraulic dredge. Six claims.

1,052,176. HYDRAULIC DREDGE. ARTHUR W. ROBINSON, OF MONTREAL, QUEBEC, CANADA.

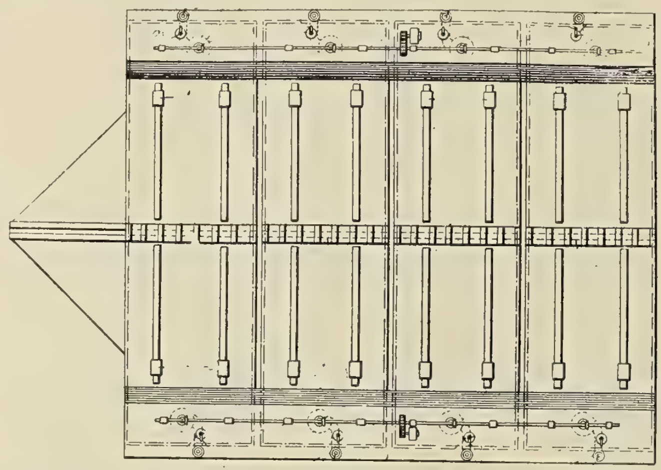
Claim 3.—In a hydraulic dredge, the combination, with a dredge hull, of a suction frame comprising two connected longitudinal plate girders, a socket casting fixed to the hull, hinge connections coupling the suction



frame to said socket casting, an outer suction pipe section supported on the suction frame, a ball casting secured to said outer suction pipe section and fitting the socket casting in line axially with the hinge connections, and an inner suction pipe section secured to the socket casting. Four claims.

1,052,225. FLOATING DRY-DOCK. WILLIAM THOMAS DONNELLY, OF BROOKLYN, N. Y.

Abstract.—The invention has for its object to provide valves, intermediate the combined inlets and outlets of the compartments of the dock and the centrifugal pumps therein, which are automatically and manually operatable to interrupt communication between the combined inlets and outlets of the compartments and the pumps therein and simultaneously establish direct communication between the combined inlets and outlets and the compartments, so as to admit water directly into the compartments of the dock; that is, without passing through the pumps, and which are automatically and manually operatable to establish communication between the combined inlets and outlets of the compartments



and the pumps therein and simultaneously interrupt communication between the combined inlets and outlets and the compartments, so as to cause the water to be exhausted from the compartments, by the pumps when they are started. Twelve claims.

1,053,047. BOAT HOISTING AND LOWERING APPARATUS. ANTHONY JOSEPH LEWKOWICZ, OF NEW YORK, N. Y., ASSIGNOR TO THE MARTIN MARINE LIFE SAVING DEVICES, LTD., OF TORONTO, ONT., CANADA, A CORPORATION OF ONTARIO, CANADA.

Claim 1.—In a boat hoisting and lowering apparatus, the combination of the davit falls, a drum on which said falls may be wound, a brake associated therewith, controlling the unwinding revolution of said drum, and means to rotate said drum arranged to be moved into and out of operative relation with it, said rotating means being prevented from moving to its inoperative position until said drum is under the control of said brake. Twenty-one claims.

1,049,490. CONVERTIBLE TANK VESSEL. CHARLES P. M. JACK, OF NEW YORK, N. Y.

Claim 1.—In a convertible freighter and tank vessel, a ship's hold, a number of removable cylindrical tanks vertically placed therein; and adjustable means connecting said tanks together and to the sides of the hold. Four claims.

British patents compiled by G. F. Redfern & Company, chartered patent agents and engineers, 15 South street, Finsbury, E. C., and 10 Gray's Inn Place, W. C., London.

5,649. IMPROVEMENTS IN AND RELATING TO SHIPS' CABINS. HOSKINS & SON, LTD., OF NEPTUNE WORKS, TRINITY STREET, BIRMINGHAM, AND W. GRAY, OF 65 FENCHURCH STREET, LONDON.

This invention relates to furniture for ships' cabins, and has for its principal object the provision of good wardrobe accommodation without encroachment on the space required for berths, sofas, etc. The bulkhead between two adjacent cabins has a central gap or space adapted to admit the fitting of which provides the combined lavatory and wardrobe accommodation for the cabins on the respective sides of the bulkhead. In each cabin the larger compartment provides wardrobe accommodation, with drawers beneath the hanging space if desired, while the smaller compartment provides for the reception of the wash basin and other utensils. The uper part of the lavatory compartment may be constructed to provide a cupboard and lockers.

5,737. IMPROVEMENTS CONNECTED WITH SHIPS' STEERING GEARS. J. R. CLAY, OF WORCESTER ROAD, BOOTLE, LANCASHIRE.

This invention relates to mechanism designed to prevent orders being wrongly carried out in connection with the steering of ships, which is performed by an engine controlled from a wheel on a shaft through gearing. For this purpose a pair of oppositely toothed ratched wheels are fixed and a pair of diametrically opposite detents are arranged alternatively to engage the wheels so as to allow the wheel to be turned in only one or the other direction according to which detent engages the wheels. The detents are operated by the person giving the orders.

24,161. APPARATUS FOR FLOODING THE COMPARTMENTS OF SHIPS. J. L. BRUNTON AND W. B. BRUNTON, WESTCOMBE PARK, KENT.

This invention relates to the flooding of the compartments of ships. On each side of the ship is arranged a main connected to the various compartments by valves and also connected by a valve to the discharge pipe from the condensers so that the whole or part of the discharge can be led to any compartment. The valves are operated by hydraulic cylinders and the supply of high-pressure water to these cylinders is controlled from the bridge or other distant point by apparatus similar to that now employed for opening and closing bulkhead doors. The mains may be supplied by a pump.

International Marine Engineering

Published Monthly by ALDRICH PUBLISHING CO.

17 BATTERY PLACE, NEW YORK — 31 CHRISTOPHER ST., LONDON, E. C.

H. L. Aldrich, President and Treasurer
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Vol. XVIII — JUNE, 1913 — No. 6

New Chinese Training Cruiser Ying Swei

BY F. C. COLEMAN

The cruiser *Ying Swei* was built by Messrs. Vickers, Ltd., of Barrow-in-Furness; and although intended primarily for the training of officers for the Chinese naval service, the vessel possesses valuable properties of an offensive as well as defensive character, and should prove an acquisition to the sea forces of the Chinese Republic.

The principal dimensions are:

Length between perpendiculars	330 feet.
Breadth molded	39 feet 6 inches.
Depth molded	23 feet 9 inches.
Mean draft	13 feet.
Displacement, approximate	2,460 tons.
Speed	20 knots.
Coal bunker capacity	600 tons.
Oil fuel capacity	55 tons.
Normal supply of coal	225 tons.

The armament of the *Ying Swei* consists of two 6-inch guns, four 4-inch guns, two 14-pounder guns, six 3-pounder guns, two 1¼-pounder guns, and two 18-inch deck torpedo tubes. The two 6-inch guns are situated on the forecastle and poop decks, and have arcs of training from the fore and aft line to 60 degrees abaft, or before the beam, respectively, on each side of the vessel. The 4-inch guns are situated on each side of the upper deck at the break of the poop and forecastle, and have angles of training from the fore and aft line to 60 degrees before and abaft the beam, respectively. The 12-pounder and 3-pounder guns are situated along each side of the upper deck amidships, and have angles of training of from 60 degrees before to 60 degrees abaft the beam. The 1¼-pounder guns are placed on each side of the navigating bridge, and have angles of training of from 30 degrees across the bow to 30 degrees abaft the beam. The torpedo tubes are situated on the upper deck aft of 'midship, and have angles of training of from 30 degrees before to 30 degrees abaft the beam. The gunfire is controlled from the forward bridge, and the torpedo tubes can be fired from the conning tower or at the tube. For the rapid delivery of the ammunition to the 6-inch and 4-inch guns electric bollard hoists have been introduced, the ammunition being protected on its way to the guns by steel tubes 1 inch in thickness.

A RECENT ACQUISITION TO THE NAVAL FORCES OF THE CHINESE REPUBLIC

An armored deck of varying thickness with sloping sides extending well below the normal waterline affords protection to the magazines and other vital parts of the ship. The disposition of the coal has also been considered so as to afford the maximum protection from gun fire. A conning tower of 3-inch Krupp cemented armor is situated on the forecastle deck, and is fitted with all the usual and necessary appliances for the working and fighting of the vessel. A steel communication tube from the floor of this conning tower to the protective deck provides protection for the various leads of shafting, etc., passing from the conning tower to the interior of the vessel.

The ship is constructed throughout of steel and divided into numerous watertight compartments by watertight bulkheads and flats. The foremost bulkhead is specially strengthened to withstand an inrush of water from the sea. A double bottom extends for almost the entire length of the vessel, and is fitted with the usual appliances for dealing with the oil fuel, feed water and water ballast. Trimming tanks are provided at the ends of the ship, and there are also tanks for the storage of a large supply of fresh water.

There is accommodation for 230 officers and men and for forty cadets. The quarters for the captain and chief officers are under the poop deck, and for the remainder of the officers and cadets under the upper deck aft. The crew are berthed forward under the forecastle and upper decks. Sick bay, dispensary, school room and the usual bath and lavatory accommodation are provided for the officers and crew. The magazines and shell rooms, steering gear and capstan engine are placed under the protective deck, and there is ample storage room in the hold and elsewhere.

A refrigerating plant is installed in connection with the cold storage arrangements and also for maintaining a low, even temperature in the magazines. The pumping, flooding, draining and ventilating systems are in accordance with the most approved practice, the ventilation system being made to suit the varying climate conditions obtaining along the sea coast of China. The *Ying Swei* is fitted throughout with a complete installation of electric lighting and power with two generating sets, each capable under ordinary conditions of supplying the electricity necessary for the ship. Two 24-inch searchlights of standard type, one forward and one aft, are fitted on specially constructed platforms, and there is a complete range-finding equipment on the compass platform forward.

The number of boats carried is similar to that provided for vessels of the same class in other navies, and includes a steam launch having a speed of 8 knots.

The propelling machinery is of the Parsons turbine type, having three lines of shafting, with one propeller on each shaft. The turbines, arranged in one engine room, comprise one high-pressure ahead turbine on the center shaft and one low-pressure ahead on each wing shaft. The wing shafts are arranged for working astern, a reversing turbine being incorporated in each of the two low-pressure turbine casings. In addition to the main steam connections to the high-pressure ahead turbine, there are separate steam connections with regulating valves fitted to each of the low-pressure ahead and astern turbines. For economical working at low speeds a cruising element is fitted in the high-pressure end of the high-pressure turbine. All the turbine bearings and shaft bearings are arranged for forced lubrication, pumps being supplied for this purpose together with an oil cooler and tanks, etc.

The main air pumps are independent direct acting, one for each condenser. The condensers are arranged in the wings of the ship, and they are cylindrical in form with the casings built up of steel plates and angles with conical ends of gunmetal. The circulating water is supplied by two centrifugal pumps, driven by independent single-cylinder engines, the pumps being also arranged to draw from the bilges.

The shafting throughout is made of forged steel and the various lengths are filleted into one another. The propellers are three-bladed, the bosses and blades being cast solid of manganese bronze. The wing propellers are arranged to work outwards when going ahead.

The distilling and evaporating machinery is of ample capacity, two evaporators, capable of supplying 35 tons of water per 24 hours and one distilling condenser capable of condensing all the steam from the evaporators, are fitted. The evaporators work under the closed exhaust system, the steam pressure in the generating coils being 25 pounds per square inch, taken from the auxiliary exhaust system or the auxiliary steam service.

There are six boilers, including watertube, cylindrical boilers and generators of the White-Forster type, the latter being arranged to burn oil fuel as well as coal. The watertube boilers are four in number, and they are capable of producing steam for about two-thirds of the total horsepower, and the cylindrical boilers are of the single-ended return tube type, designed to work under the forced draft, closed stokehold system. The total heating surface is 12,900 square feet and the total grate area is 287 square feet. Air is supplied to the stokehold by six steam-driven fans of the double inlet type, the engines being of the enclosed type fitted with forced lubrication. The feed water is supplied to the boilers by four feed pumps of Weir's direct-acting type.

The results attained during the official speed and other trials of the *Ying Swei* are shown in the table:

	24 Hours' Trial. Mean Result of Whole Trial.	24 Hours' Trial. On Measured Mile.	Full Power Trial. On Measured Mile.	Two Hours, Oil Fuel with Cylindrical Boilers Only.
Shaft horsepower	1,100	1,278	6,375	2,088
Mean revolutions, three shafts.	311	330.6	556.5	396
Speed on revolutions	12.3	.....	.....	15.8
Speed on miles	.....	13.14	21.21	.....
Coal consumption, pounds per horsepower per hour	2.6	.....	.....	.....

First Ship Built on Manhattan Island.—Just 300 years ago, in 1613, occurred the first shipwreck in New York Bay, and the same year saw the building of the first ship ever built by white men on Manhattan Island, says a recent writer. A company of merchants in Amsterdam sent out five vessels loaded with goods to be traded with the Indians in America. Among the skippers of the vessels was Adrian Block, commanding the *Tiger*. Some time in the latter part of 1613 the *Tiger* caught fire and was completely destroyed. The captain and crew immediately started to build a new vessel, and it was finished and launched early in the following spring. The ship is generally supposed to have been built on the site of what is now Fraunces Tavern.

Marine Freight Terminals in Minnesota.—The State of Minnesota evidently appreciates the necessity of having steamboat landings and the handling of freight at them under the control of local authorities, with power to control such facilities. A law has just been enacted giving Minnesota cities the power to acquire lands and construct, maintain and create docks, wharves, levees and other terminal and storage facilities along and adjacent to the Mississippi River and other navigable waters, and to issue bonds to pay for such facilities and improvements.

Shipping in the Philippines.—Vessels from foreign ports entering Manila Bay during 1912 numbered 811, representing a total of 1,779,635 net tons. The port of Manila is dredged to a depth of 30 feet, and has two piers 550 by 75 feet and 650 by 110 feet, respectively, with another planned to be 750 by 160 feet.

Mechanical Gearing for Propulsion of Ships*

BY THE HON. SIR CHARLES A. PARSONS, K. C. B., D. Sc., F. R. S.

The subject of the application of steam turbines with mechanical gearing to ship propulsion has already been brought before the notice of this institution in papers read by the author in 1910 and 1911. These papers described the experimental installation in the cargo steamer *Vespasian*, the successful results obtained with which have since that time led to considerable development in this type of propulsion. It is the object of the present paper to give an account of the progress that has been made up to the present time.

Geared turbine propulsion is in this country now well advanced beyond the experimental stage. There are already in actual service cargo steamers, Channel steamers and warships, together representing a total of about 26,000 horsepower, developed by steam turbines and transmitted through mechanical gearing, and there is at the present time under construction turbine machinery and mechanical gearing representing a transmission of over 120,000 horsepower, including two installations of over 20,000 horsepower each.

Geared turbines have been fitted in two Channel steamers for the London & South-Western Railway Company's service between Southampton and Havre, the steamships *Normannia* and *Hantonia*, of 1,900 tons displacement, having a shaft-horsepower of 5,000 at a service speed of about 18 knots. These installations were fully described in a paper read before this institution by Prof. J. H. Biles in 1912. They continue to show an economy, as compared with other turbine steamers on the same service, of about 40 percent, due partly to increased efficiency of turbines, partly to increased efficiency of propellers with the lower revolutions adopted, and partly to improved form of vessel incidental to the reduction in boilers and the adoption of twin screws. The *Normannia's* gearing has been recently inspected after steaming over 26,000 knots, and was found to be in perfect condition; no wear whatever can be detected.

Geared turbines have also been installed in three Channel steamers for the Indian Ferry service between India and Ceylon, in accordance with designs and specifications prepared by Sir William White. The first of these, the *Curzon*, has successfully passed her speed trials, and considerably exceeded the speed guarantee undertaken by the builders of the vessels and propelling machinery, Messrs. Inglis & Company, Glasgow. The reduction gear was made by the Parsons Marine Steam Turbine Company.

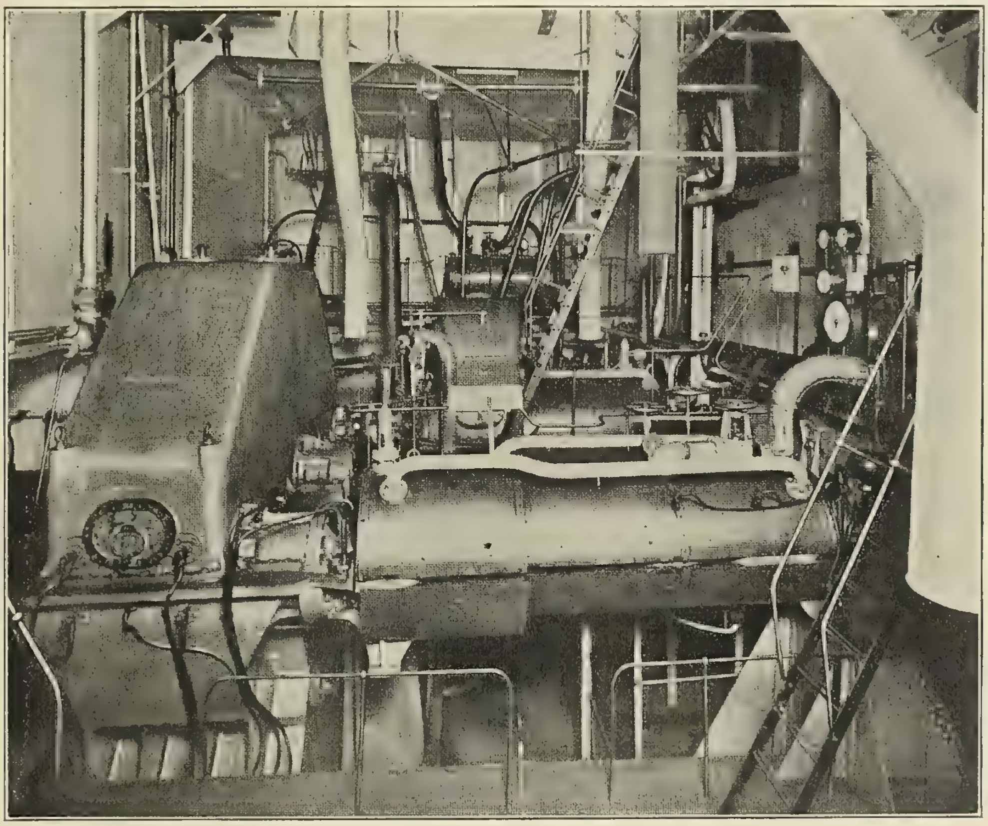


FIG. 1.—ENGINE ROOM OF STEAMSHIP CAIRNROSS

A cargo steamer built for the Cairn Line by Messrs. Doxford, Sunderland, has been recently fitted with an installation of geared turbines (Fig. 1) similar to that adopted in the *Vespasian*, consisting of two turbines, a high-pressure and a low-pressure turbine in series, capable of developing about 1,600 shaft-horsepower, which is transmitted through mechanical gearing to a single propeller shaft at 63 revolutions per minute, the speed of the vessel being about 10½ knots. It is interesting to notice that a coal consumption trial has been made this ship running side by side with a sister ship, the *Cairngowan*, with exactly similar boilers and propeller, but with triple-expansion reciprocating engines, the coal supplied being of the same quality and measured in the same way on both ships, and the geared turbine ship has shown a saving of 15 percent in the coal consumption.

* Abstract of a paper read before the Institution of Naval Architects, London, March, 1913.

So far no limit in regard to the surface speed of the teeth has been discerned, and there is no evidence of any limit to the power that can be transmitted by mechanical gearing with gear wheels suitably designed. It appears that this type of propulsion can be adopted with advantage in all classes of work ranging from low-speed cargo steamers to high-speed destroyers and battleships and liners of large powers, and

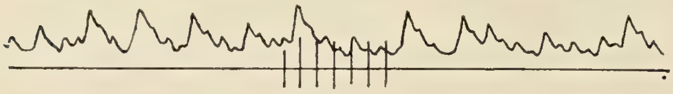


FIG. 2

there can be little doubt that it will be extensively employed for all classes of ships in the near future.

A few illustrations are given at the end of the paper of typical arrangements of geared turbine machinery.

Fig. 3 shows an installation of geared turbine machinery suitable for a cruiser of about 30,000 horsepower on two shafts at 300 revolutions per minute.

Fig. 4 shows an installation suitable for a destroyer of about 20,000 horsepower, with twin screws at 440 revolutions per minute. It will be seen that the installation consists of a high-pressure and a low-pressure turbine driving each shaft, and an additional cruising turbine geared with one of the shafts for employment at low speeds.

Fig. 5 illustrates a design for a battleship of about 40,000 horsepower, with four shafts at 200 revolutions per minute. In the arrangement illustrated there are two turbines geared to each shaft, the turbines on the two shafts on either side of

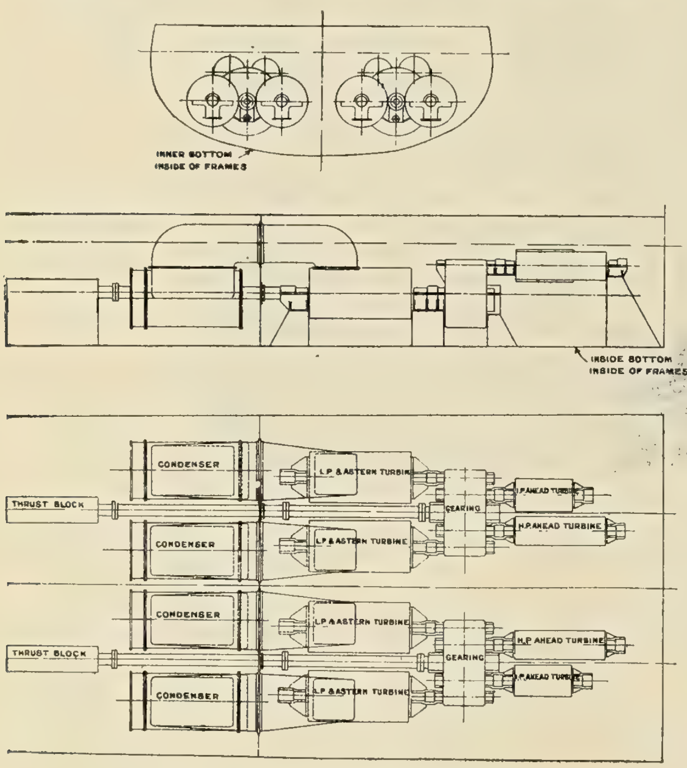


FIG. 3.—TYPICAL CRUISER INSTALLATION

the ship being arranged in the well-known four-cylinder triple formation, each group consisting of a high-pressure, an intermediate-pressure and two low-pressure turbines, an arrangement which leads to a high efficiency both at full power and at cruising speeds.

Fig. 6 shows a further design for a battleship of about 60,000 shaft-horsepower, with geared turbine machinery on four shafts, which also includes an additional set of small turbines and gearing for use when cruising. In such an arrangement the gear wheels of the cruising set would be connected to the propeller shafts through clutches, and the main gear wheels also clutch-connected, so that whichever set of machinery was in use the other set could be entirely disconnected from the propeller shafts, and all losses from idle running avoided. This separate cruising installation would have its own small condensing plant, or could make use of the small

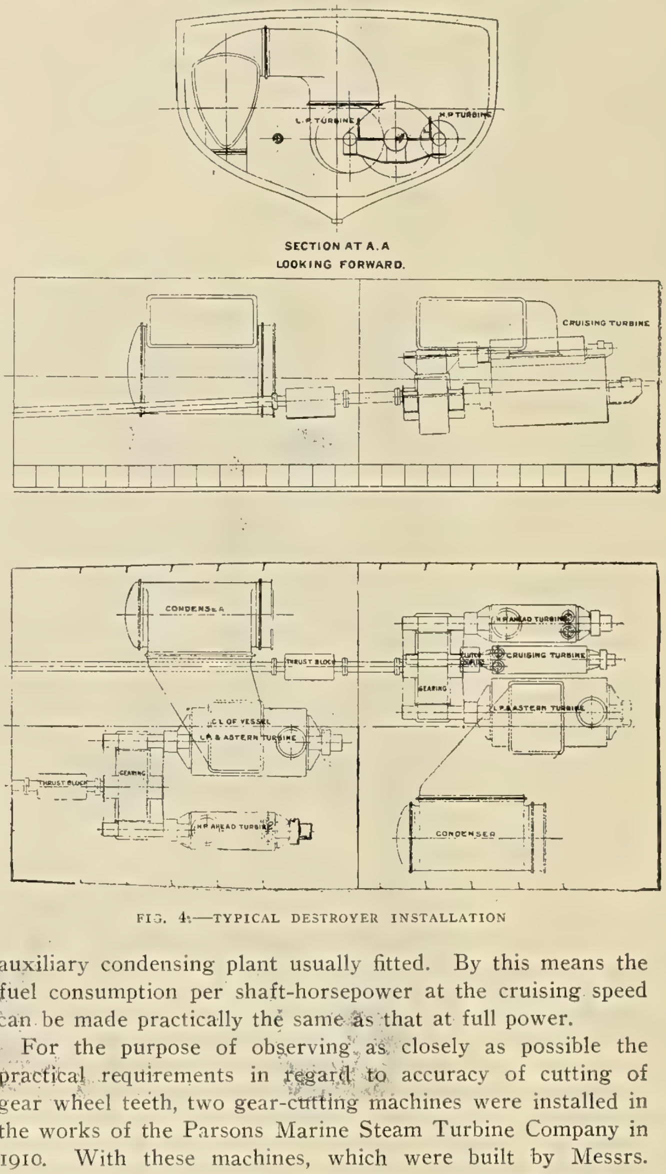


FIG. 4.—TYPICAL DESTROYER INSTALLATION

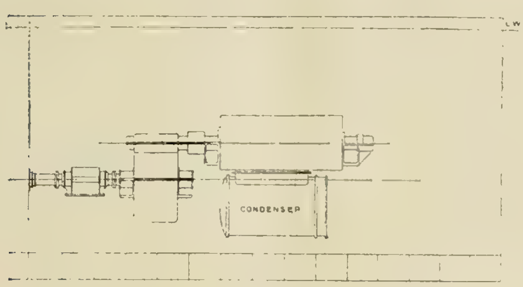
auxiliary condensing plant usually fitted. By this means the fuel consumption per shaft-horsepower at the cruising speed can be made practically the same as that at full power.

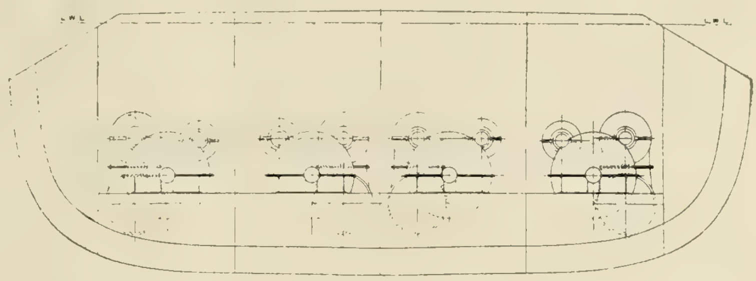
For the purpose of observing as closely as possible the practical requirements in regard to accuracy of cutting of gear wheel teeth, two gear-cutting machines were installed in the works of the Parsons Marine Steam Turbine Company in 1910. With these machines, which were built by Messrs. William Muir & Company, Manchester, tooth faces are automatically generated by the process known as "hobbing." These two machines have, since they were installed, cut gear wheels representing a transmission of about 50,000 horsepower, and the experience thus gained in this work has enabled several important improvements to be made to them.

Two similar machines were installed in the works of Messrs. C. A. Parsons & Company, Heaton, Newcastle-on-Tyne, for the manufacture of geared plant for the driving of electrical generators, rolling mills, work shafting, etc.

Examination of the teeth of gear wheels which have been running for some little time, transmitting large powers, shows the work to be distributed over the teeth with fair uniformity, and confirms the opinion expressed by the author before this institution in 1910 in his reply to the discussion on the first of the papers above referred to, that with double helical gear such devices as floating frames for the pinions or hydraulic pistons to distribute the load equally over the pinion bearings are totally unnecessary, the natural elasticity of the supporting structures providing all the accommodation necessary, assuming, of course, reasonably accurate alinement of the shafts. The pinions are in all cases connected to their turbine shafts by flexible couplings, which allow them longitudinal freedom, and this in itself, with double helical gears, ensures that the load is practically equally divided between the right and left-hand portions of the gear.

Careful investigations have been made of the causes producing noise, with the object of removing such causes and obtaining a silent gear. These investigations show the noise to be due to slight inaccuracies in the teeth, the order of accuracy required for silent gearing being higher than present gear cutting machines are capable of affording. Fig. 2 is reproduced from a photograph of a microphone oscillograph record obtained from a double helical gear wheel by suspending over the gear case a microphone connected with an oscillograph. It will be observed that definite notes are produced. In the particular case illustrated the frequency was found to be 160 times the number of revolutions of the wheel, and its source was traced to the parent gear of the gear-cutting machine, viz., the single worm and the 160 teeth of the worm wheel which rotated the table on which the work was mounted while the wheel was being cut. The inaccuracies of this gear were carefully measured, and found to be co-periodic with the worm wheel teeth, and to have a double amplitude of about four-thousandths of an inch.





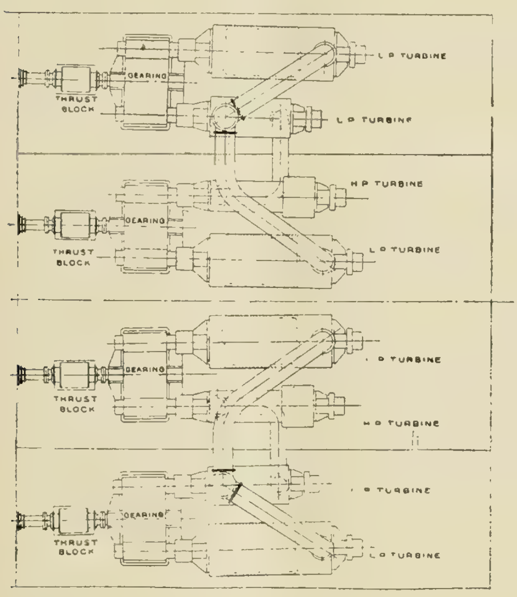


FIG. 5.—BATTLESHIP INSTALLATION

In the case of the gear wheel referred to above, as there did not appear at the time to be any means of removing the irregularities from the teeth, and very silent running was desired in this instance, stiff springs were fitted above and below the bearings, having a small amount of initial compression and permitting a movement of about 1/100 inch as the load was increased to its full value. The pinions being thus flexibly supported, noise and shock were to some considerable extent intercepted, instead of being transmitted to the structure of the gear case.

It was recognized, however, that spring supports were an imperfect remedy, the real remedy being a higher degree of accuracy in the teeth. To attain this it was necessary either to greatly increase the accuracy of the parent gear or to devise means of cutting which did not reproduce the errors of the parent gear, and, what is still more important, avoided periodicity in the residual errors. It was obvious that progress along either of these lines, or possibly along both at once, would result in valuable improvement of mechanical gearing for the transmission of large powers at high speeds.

It is doubtful whether at the present time a worm and worm-wheel drive of the strength required in gear-cutting machinery can be relied upon to have a higher degree of accuracy than the drive of the machine referred to above, but by the use of multiple drives, such, for instance, as several worms driving one worm wheel, it will be readily seen that these errors would, to a considerable extent, compromise each other.

An improved method of cutting gear-wheel teeth has, however, been developed by the author and his colleagues. Primarily, it aimed at destroying the periodicity of the errors, but incidentally it also accomplishes a considerable reduction of the errors themselves present in the parent gear.

It will be seen that in the process ordinarily adopted, in which the work is mounted on a table rotated by means of a worm and worm wheel, the latter being attached permanently to the table, the errors will be some function of the angular position of the work, and therefore lie in planes through the axis of rotation; and if, as is mostly the case, the errors of the parent gear are periodic, these planes will lie at equal angular intervals, and will come into mesh periodically. Now, it will be seen that if the work is given a small, steady advance in relation to the table, the errors, instead of lying in planes through the axis, will lie in spirals around the wheel, and that when put to work they will be obliterated and leave a true wheel.

In the adaptation of this new principle of cutting to an existing gear hobbing machine, a secondary table is mounted on the original table of the machine, and given a creep in advance of 1 percent in relation to it by means of a train of gearing, the main worm driving the lower table being driven at 1 percent less speed, so as to secure the same rotational speed as before the creep was introduced.

While the most important effect of this arrangement is that the errors in the teeth will lie in very oblique spirals around the wheel, resulting in great uniformity in the gearing, at the same time it has also an important effect in reducing the errors themselves. In fact, three things have been accomplished. In the first place the errors have been reduced to about one-fifth of their original magnitude; secondly, they are spread

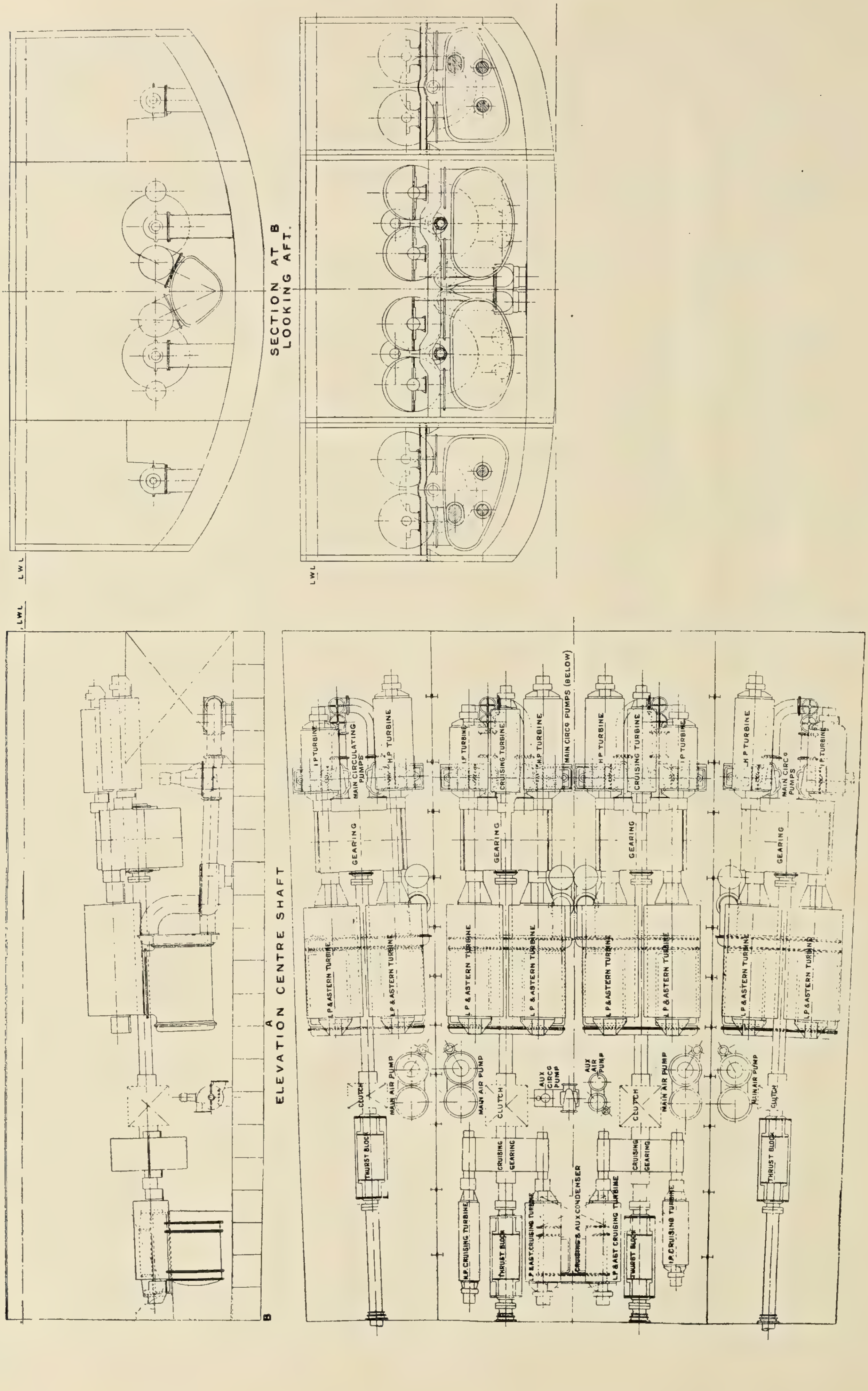


FIG. 6.—BATTLESHIP INSTALLATION, WITH SEPARATE CRUISING TURBINES

across the wheel in such a way that periodicity is avoided, and, thirdly, they consist of cuspidal ridges which will be easily reduced by grinding or wear and leave a practically true wheel.

Anti-Destroyer Guns

BY SIDNEY GRAVES KOON, M. M. E.

Ever since the torpedo boat first cast its menace across the waters, measures have been taken looking to destroy it before it could get within striking distance. Rapid-fire guns, throwing a score of shots per minute, have been developed, until the sides of some ships fairly bristle with them. The Russian *Tri Sviatitelia,* launched in 1893, has fifty-two rapid-fire guns of 1-pounder and 3-pounder size. The *Oslabya* (1898) had forty-six. On the *Kniaz Suvaroff* (1902), Rozhdestvensky's flagship, sunk at the battle of the Sea of Japan, were forty-eight, of which twenty were 12-pounders—the balance 3-pounders and 1-pounders. The increasing size was due to increasing ranges at which torpedoes were being discharged effectively.

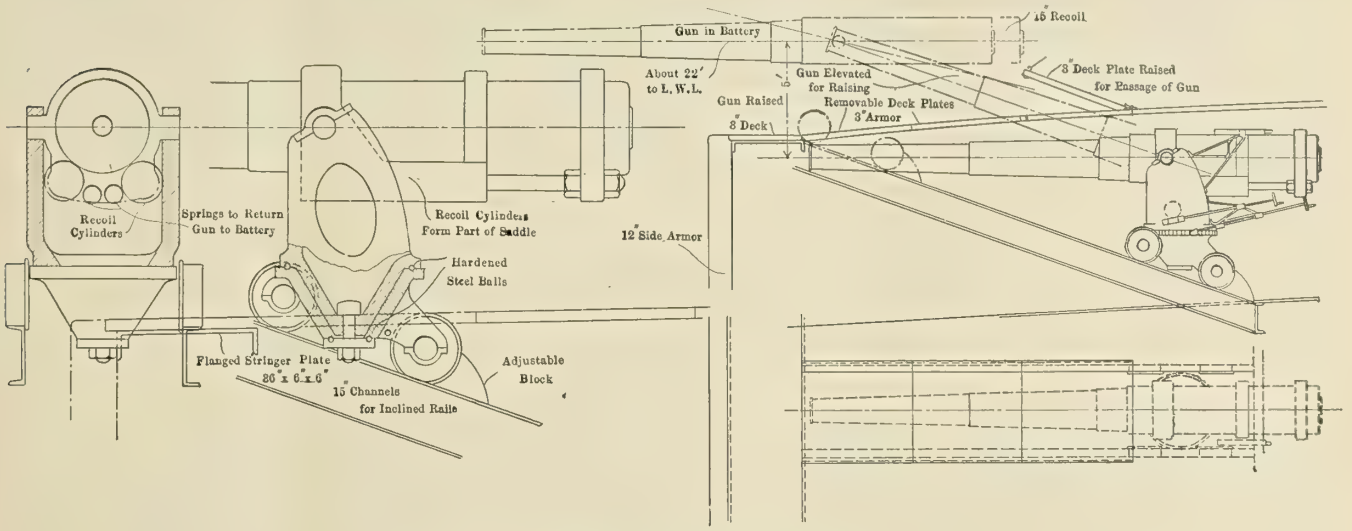
The United States navy used 6-pounders for this work long after England had substituted 12-pounders. This may have been due, at least in part, to the difference in power of the fleets of torpedo craft being developed in Europe and in America, respectively. Then the American 14-pounder persisted until we find it in the first two dreadnoughts. It has now been replaced everywhere by the 5-inch piece, throwing a 50-pound projectile.

England adopted the 4-inch, 31-pounder, after the first *Dreadnought,* and has now jumped to the 6-inch, 100-pounder. Germany uses the 5.9-inch and 6.7-inch associated with the 3.4-inch, 24-pounder. Japan uses the 6-inch and 4.7-inch, 45-pounder, in the same ship. France has come to the 5.5-inch after long clinging to the 9-pounder (the 14-pounder was mounted on six ships only).

In practically every case the guns under 5 inches are without armor protection. With the advent of the heavier, costlier and more destructive anti-torpedo weapon has come a disposition to protect it. In many of the latest designs these guns will be found behind armor from 6 inches to as much as 9 inches in thickness. It is realized more and more that, with the increasing destructiveness of the under-water projectile, a more positive means must be adopted of keeping its carriers at a respectful distance. This has meant not only the heavier guns, as noted, but also the conserving of the power in those guns until the time when, after the artillery duel, the destroyer attack is loosed.

But in all designs as yet made public, the anti-torpedo battery is undeniably susceptible to being put out of commission by the fire of the opposing primary guns, especially if the combat is at all prolonged. Their armor protection is too light to withstand the attack of these heavier pieces, and the long, slender chases of the guns themselves, protruding 12 or 15 feet from their ports, seem actually to invite disaster. Any combatant, strong in destroyers, would be sure to devote especial attention to attacking these light guns, with the idea of being able to deliver his coup-de-grace with the destroyers as soon as the enemy should be deprived of his best defense against them.

For this reason it is becoming ever more imperative to install the guns under such conditions as to make certain their being usable even after a long, stubborn conflict. They should be so disposed and so protected that no hostile torpedo craft could approach from any angle, even after the battle, without meeting a storm of shell from them—a storm which would search out its vitals before it could come within the 4 miles now considered effective modern torpedo range. Hence the appeal of the design herewith submitted, which has been worked out in connection with that of a very powerful battleship of unusual size.



DETAILS OF PROPOSED MOUNTING FOR ANTI-DESTROYER GUNS

It is proposed to mount each gun carriage upon four wheels, running upon rails having an inclination or "grade" of about 20 degrees. At all times when not in use the gun reposes comfortably back of the 12-inch upper-side armor and beneath a 3-inch deck. Here it is unusually secure during the artillery stages of the battle, and until it is needed to repel the lighter but in many respects more dangerous assault. No chase projects to be shot off or cracked or to transmit to the carriage the energy of impact of a half-ton shell. All is completely under cover until called upon for action.

Then the manual removal of two 2,475-pound deck plates, the raising of a third about its hinges, and the elevation of the gun muzzle through 20 degrees, permit the weapon to be drawn forth from its retreat, and to assume its station on the broadside, clear of all the encumbrance of a narrow, constricted port, and having a clean sweep through a wide arc from its position 22 feet above the water. The hinged deck plate is lowered, and one of the others put back in place, thus leaving an unbroken deck from which to operate the gun. The raising of the gun itself through a vertical 5 feet, while it is run forward about 14 feet, is accomplished by four men with a triplex hoist attached under the flanged stringer plate, and should consume less than one minute.

With the gun carriage securely held in position by the adjustable block back of the rear wheel, as well as by a clamp-locking device holding it to the rails on either side, its two sets of hardened steel balls in steel races give it a free movement in training, and enable it to be brought to bear on any object within the arc over which it can swing without fouling the next (similar) gun on either side. The gun barrel recoils in its sleeve against the resistance of two hydraulic cylinders (water and glycerine) and two heavy springs. The springs return it to battery. Training and elevating gear are at the hands of the gun pointer, whose telescope is attached to the carriage, and hence does not recoil or follow the gun's elevation.

The space required below decks for this gun is no greater than for a gun mounted in the usual way, even though it does carry its whole 21½ feet well within the hull lines. But it is located in a narrow well, so to speak, and thus uses a minimum of fore-and-aft space. The weights involved, aside from the rails, are about as before. Simplicity is the keynote of the design, and reliability and absolute security its whole raison d'être.

German-Built Motor Ship Hermann Krabb

BY DR. ALFRED GRADENWITZ

The German Navigation Company Teutonia, of Montevideo, which has recently been founded as a branch of the Hamburg firm of Messrs. Hermann Krabb & Company, is intended to insure traffic throughout the course of the river La Plata. Among the vessels taken into use by this company, the motor ship *Hermann Krabb* is by far the most remarkable. This vessel has been built at the yards of Messrs. Stocks & Kolbe, of Kiel-Weddingdorf, and is equipped with two marine Diesel engines on the Hesselman system, manufactured at the shops of Messrs. Benz & Company, of Mannheim. The *Hermann Krabb,* therefore, can be described as the first motor ship of German origin intended for a foreign country.

The hull has been built in accordance with the requirements of the service from first-class materials, its main dimensions being:

Length over deck	189 feet.
Length between perpendiculars	182.2 feet.
Breadth of frames	30.4 feet.
Molded depth	9.2 feet.
Draft	6.6 feet.

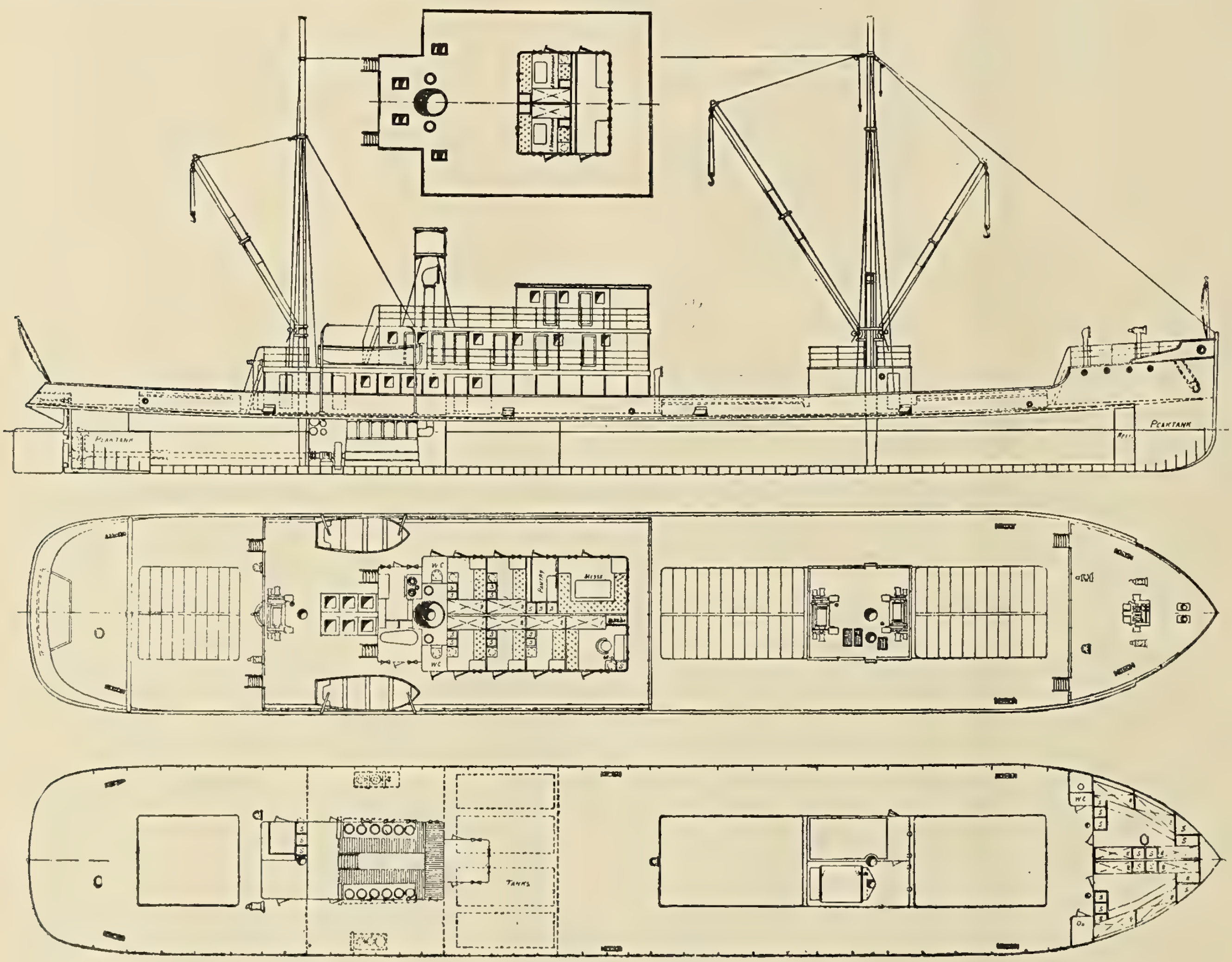


FIG. 1.—PROFILE AND DECK PLANS OF MOTOR SHIP HERMANN KRABB

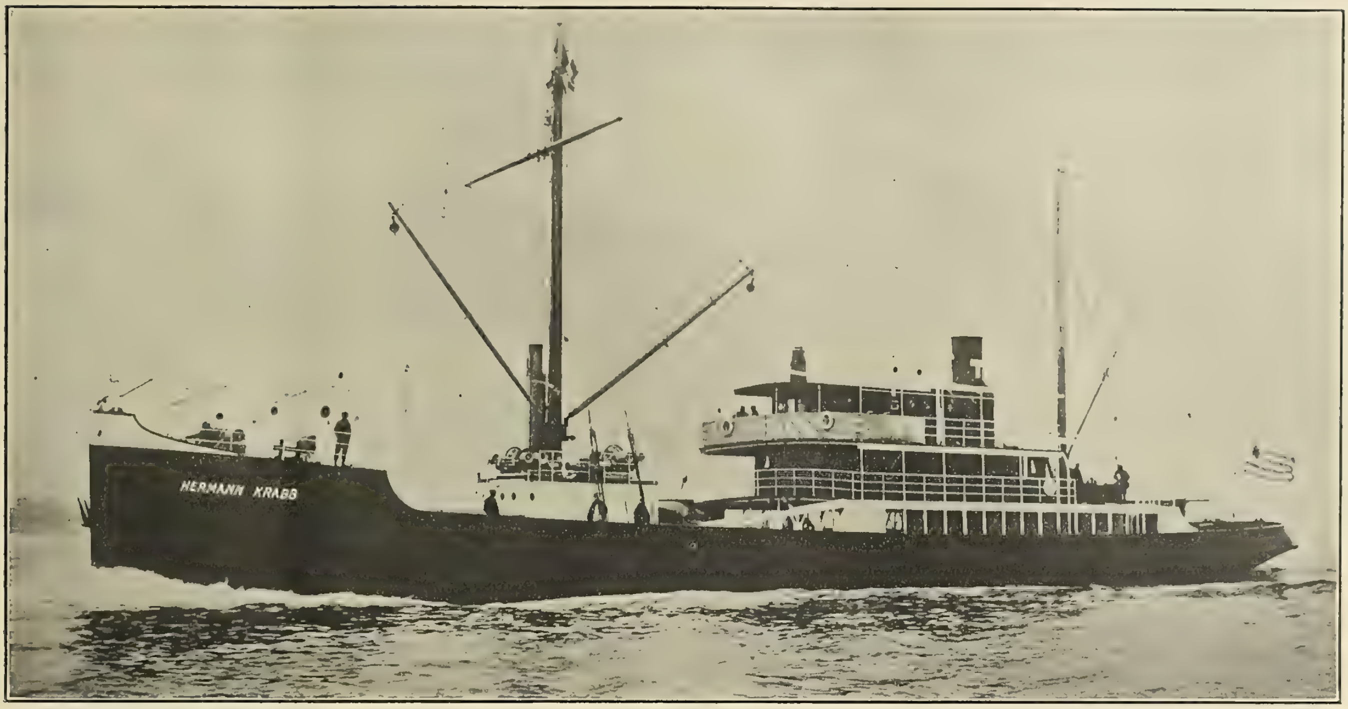


FIG. 2.—THE FIRST MOTOR SHIP BUILT IN GERMANY FOR A FOREIGN COUNTRY

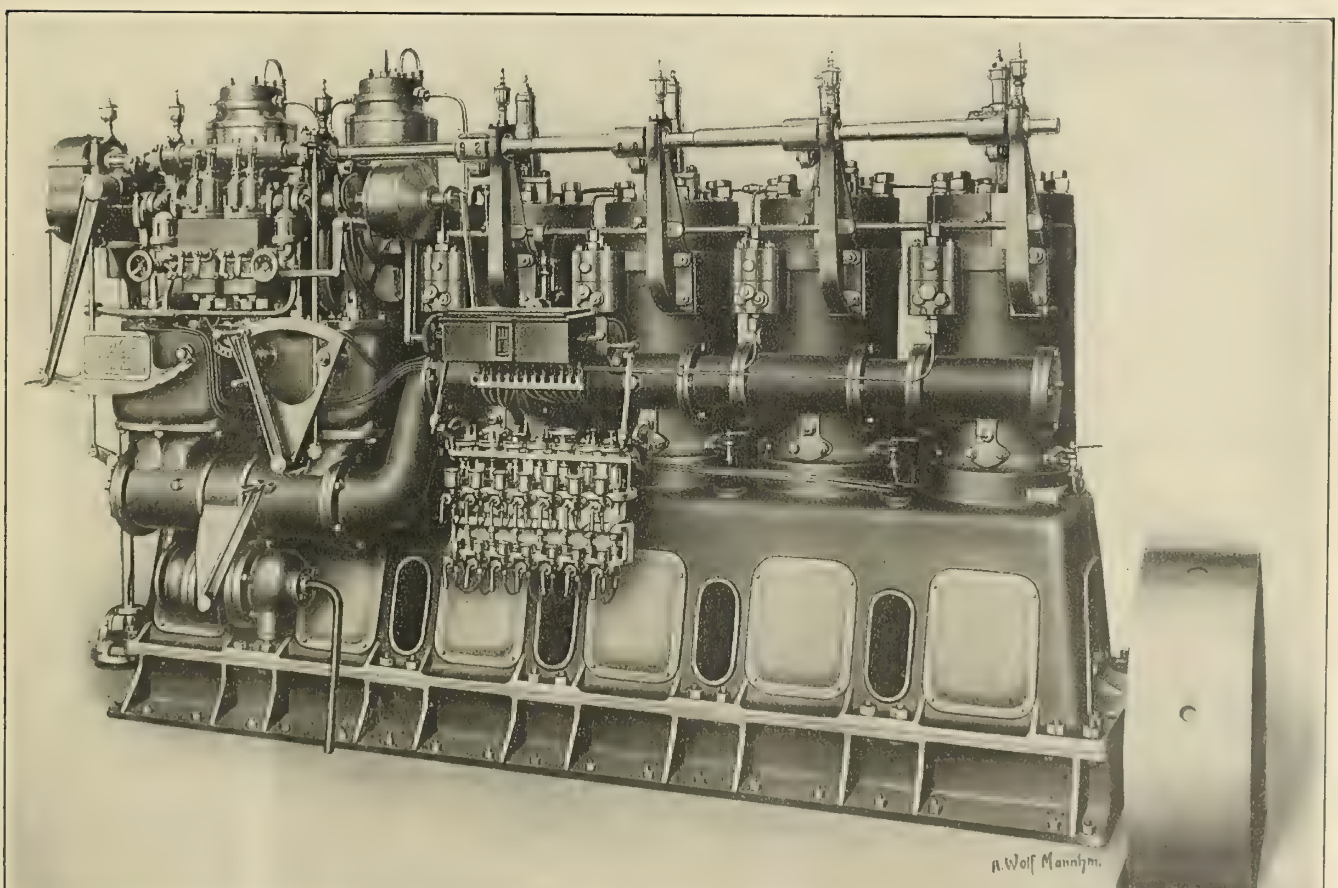


FIG. 3.—DIESEL ENGINE OF THE HESSELMAN TYPE FOR THE HERMANN KRABB

With a draft of 6.6 feet the loading capacity is 400 tons, apart from a store of 65 tons carried in the fuel tanks. This small draft enables the vessel, even on shallow river sections, to penetrate farther into the interior than a steamer.

The load is installed in a large hold in the fore part of the vessel, which is accessible through two hatches, and a small hold with one hatch behind the engine plant. Above the holds there are hoists equipped with all necessary derricks of 3 and 5 tons capacity. All loading winches are operated by steam generated by a donkey boiler, hand operation being provided for cases of emergency. Below the fo'castle there are rooms for the sailors and machinists as well as compartments for storing tools and accessories. Cabins on the boat and bridge deck are provided for the passengers and officers, these teak structures being reinforced by substantial iron frames and fitted up most comfortably in the interior.

The service of the whole engine plant is quite uniform, crude oil being used for the operation not only of the main engines but of the auxiliary machinery, while even the donkey boiler, built into the deck, is heated with oil. The main engine plant comprises two directly reversible marine Diesel motors, on the Hesselman system, working on the two-stroke cycle. Each engine comprises four working and two air pump cylinders, and yields an output of 260 effective and 345 indicated horsepower at 280 revolutions per minute. Suitable reservoirs are provided for storing the compressed air required for starting and reversing, thus enabling the engine to be started and reversed ten to 15 times in succession without replenishing its store of air. On account of the tropical climate of the country, special arrangements had to be made for a rapid circulation of the cooling water, so that the water temperature might not exceed 30 degrees C. The fuel, after being purified and pre-heated, is pressed onto the nozzle by adjustable fuel pumps.

The piping for the main engine could be readily installed in the engine room in conjunction with the auxiliary machinery and water filters for the cooling water. The following auxiliary machinery has been provided: An auxiliary compressor to be used as stand-by for supplying the steering apparatus and replenishing in cases of emergency the starting air reservoirs. This set comprises a 5.5-horsepower kerosene (paraffin) motor working at 420 revolutions per minute, and a compound compressor and intermediary cooler which supplies air at 10-12 atmospheres pressure. This motor is at the same time coupled on a common base to a donkey pump. A motor dynamo, operated by a two-cylinder, 10-horsepower, 420 revolutions per minute kerosene (paraffin) motor, has been installed for generating electric current. The steering apparatus comprises a steam and hand steering gear designed for compressed air operation, which is controlled from a hand-wheel column on the upper deck.

The engine plant provided ensures a speed of 10 miles with full load, the fuel consumption being 243 pounds, so that about 600 sailing hours without replenishing are possible with a single store of 65 tons, which corresponds to an up and down trip on the La Plata.

On her passage from Hamburg to Montevideo, the *Hermann Krabb* amply demonstrated her seaworthiness, as the heavy seas in the channel and the Bay of Biscay, as well as alongside the coast, were an ample test of the maneuvering capacities of the vessel.

Lake Steamship Merger.—The Interlake Steamship Company, formerly the Lackawanna Steamship Company, has effected the merger of a large number of Lake ore boat interests, purchasing thirty-two vessels, giving the company a fleet of thirty-nine ships, the second largest fleet on the Great Lakes.

Filtering Feed Water

BY CHARLES S. LINCH

While in years past little or no attention was paid to boiler cleanliness, to-day it is becoming more generally appreciated that cleanliness in a boiler means absence of dirt—and dirt, as Lord Palmerston has defined it, is matter out of place. A boiler was designed not to be a receptacle of foreign matter but to contain water and steam. The doctors of the present day are trying to prevent disease by stamping out dirt, rather than using correctives. There is nothing which is more amazing than to see some owners permitting their engineers to use correctives in the form of boiler compound of which little is known, pouring it in without any knowledge to regulate the conduct of the "dirt."

Exercising the utmost care it is absolutely impossible to prevent some oil getting into the steam. Piston rods must be swobbed, and a greater quantity of oil is taken into the low-pressure cylinder by the vacuum which causes the greater quantity to find its way into the steam. Auxiliary engines are the cause of the greatest trouble with oil passing over with the steam, because the oilers as a rule see that these are given a more than ample dose of oil, the temptation to do so being irresistible.

The function of the feed filter is to extract the oil, grease and other dirt from the feed water. The work done by a grease extractor or filter can be judged from the following analysis, made by Mr. A. Norman Tate, of the deposit from an Edmiston filter: Fatty and oily matter consisting of

Fatty matter	29.96	
Mineral oil	19.42	
Water	29.6	
		78.98
Mineral matter consisting of		
Silica	1.49	
Oxide of iron	16.46	
Lime	0.75	
Copper	2.32	
		21.02
		100.00

The copper appearing largely in solution with fatty acids. The following analysis by Messrs. Pattison & Stead, of Newcastle, is very interesting, as it is of the sludge removed from the Harris filters in the Atlantic mail steamer *Campania:*

Heavy oil dissolved out with ether	55.34
Organic matter insoluble in ether	4.69

Mineral matter left on calcining the residue, comprising iron oxides in greatest proportion, copper, zinc, oxides, salt and a

Little sand	20.9	
Moisture	19.76	
		100.00

Feed water from the condenser (in engines where oil is used in the cylinders of main or auxiliary engines) when put in a glass bottle or sample tube, has a milky or opalescent appearance and soapy feeling. After passing the filter it should be quite clean. The deposit on filter cloths and grids is, as a rule, a dark, heavy and sticky conglomerate, resembling mud. The requirements of a grease extractor or filter should then be as follows:

It will consist simply of a mass of finely divided material not easily decomposed by the feed water.

All feed water must be made to pass through it, and in passing is cleared of matter held in suspension, this being due to the straining and partly due to exposure to contact with numerous surfaces on which all matter which is of greater consistency than pure water adheres. The filtering material becoming ladened with this deposit must be frequently cleaned, and when necessary renewed. The effective duration of a filter depends upon the area of filtering material at right angles to the direction of flow. It will also depend upon the thickness of the filtering material, or, what will be the same thing, the number of strata of a given thickness.

The restrictions of space in the engine room of the average ship render it necessary that the filters be made of small dimensions, and hence they require frequent cleaning. The proper location of the filter is most important. If the filter is situated between the feed heater and boiler the water may be 220 degrees F. or more. At these temperatures some of the oily matter in the feed water is near its vaporizing point, while the remainder is liquified to such a degree that a quantity passes easily through the filter and as readily as pure water would.

Under such conditions as above, filtration is conducted under boiler pressure, and hence the shell, bonnets, joints, etc., of the filter must be heavy. The work of filtration should be at the lowest possible temperature, for the following reasons:

Oil, grease and other matters are in their most glutinous, viscous state, or, in other words, their least fluid conditions. Some impurities which are in suspension at 100 degrees F. are in solution at 250 degrees F.

The filter will therefore be more efficient at lower than at higher temperatures, and it is very desirable to keep the feed water heater, the cold and hot pumps, valves and pipes to and from them clean, and this can only be accomplished by passing the filtered water through them, and this means that the suction side of the hot well or feed-tank pumps is the most desirable location. This location presents difficulties, however. The hot well works as a rule under very little "head," and the resistance of the filter has to be overcome by the negative pressure in the suction pumps, and this resistance must not exceed 5 pounds per square inch, and less than this is desirable. Hence we either have to adopt larger filters or more frequent cleaning will be demanded.

We may ask the question, "Why not place the filter on the exhaust steam entrance to the condenser and eradicate the grease trouble entirely from all interiors beyond the cylinders?" The auxiliary engines are by far the heaviest consumers of oil, and all auxiliary piping and condensers are therefore more especially guarded by these exhaust steam filters. The objections to the use of exhaust steam filters are, however, the very high temperatures, inefficient filtration, and great area of filtering medium necessary to prevent injurious back pressure.

Summing up, we can see that the most desirable, practical and convenient location for the filter is the discharge of the hot well pumps, or between the hot well pump and feed water heater, for a low temperature is then secured, and the pumps give head enough to permit the filter being placed at a level to suit engine room arrangements, permitting the accessibility it demands.

A feed water filter should be so designed that renewals can be made simply and quickly. It should also have a device for applying a reverse current of steam to enable temporary cleaning being made. It should be light, strong and durable, cheap to maintain, economical of space, simple in design and moderate in cost. The filtering surface should be at least 250 to 300 times the area of the feed water pipes. It should be strictly borne in mind that no filtering area is efficient after the clogging point has been reached. Many statements are made that certain materials are used and that the efficiency never becomes impaired. This is not true. It makes no difference what material is used for filtering the feed water if the area is insufficient to take care of the demands of the boilers. Filtering cannot therefore be efficient beyond this clogging point.

Repeated experiments and tests have proved that the first layer through which feed water passes should in no cases be less than 100 times the area of the feed water pipe with a normal flow of water through it.

The requirements which should be met in a feed water filter are as follows:

First. It must not have single filtration, but as a matter of fact double filtration and over should be obtained. The filter would thus present a total surface area not less than 320 times the area of the feed water pipe.

Second. The facilities with which renewals or change can be made must receive particular attention. The attachments should be reduced to a minimum, at the same time assuring absolute safety. The simpler and more rapid method of dismantling is a very important feature, and is on shipboard an absolute necessity.

Third. A most important feature is the special attachments for applying a reverse current of steam, enabling a large proportion of the collected oil to be blown out and drained off through the drain cock. The filter medium should be Turkish toweling ("Linen Terry Cloth").

In a filter, the radial plan of filtering cages admits extreme surface area within any given cylinder. The over-heating of crown sheets, due to dirty feed water or so-called grease damage, as a rule, occurs after fires are banked, for then, the formation of steam being checked, the circulation of water is reduced, and hence grease will settle and become partially baked to the surface or tubes on which the deposit is in contact, with the result that it prevents contact of water with the crowns, resulting in the overheating of the plates to such an extent that bulging is very likely to and frequently does occur, even though the temperature at this time is very low. Grease does not dissolve or decompose, nor will it remain on top of the water in a boiler. It assumes the form of a sluggish conglomerate held in suspension for a short time. After boiling, this conglomerate mass becomes sticky and adheres to the shell, tubes and crown. It is becoming more fully realized by the average ship owner that all methods of preventing impurities from getting into the boiler which would in any way jeopardize not only the life of the boiler but the safety of same is a matter that cannot be ignored. Not only with the use of impure feed water is the life of the boiler reduced, but admitting that there would be no danger of bulging crowns, or other injurious effect to the generator, the consumption of fuel is enormously increased by deposits on the heating surface. Therefore, in a feed water filter the feed water, after passing through it, must not contain the least degree of insoluble matter.

Clean tubes and surfaces mean efficient heat transmission, therefore by keeping the impurities from the boiler there is a dividend returned in a high percentage of fuel saving.

Launch of the Steamship Congress.—The twin-screw coastwise steamship *Congress*, designed by George W. Dickie, and under construction by the New York Shipbuilding Company for the Pacific Coast Company, was launched May 17. The ship is 442 feet 6 inches long over all, 55 feet beam, 38 feet 5 inches depth to shelter deck, 54 feet 10 inches depth to boat deck, with a gross tonnage of about 8,000. Propulsion is by two triple-expansion reciprocating engines of 3,000 indicated horsepower each, designed to give the vessel a speed of 16½ knots. Steam is supplied by ten boilers, arranged in two fire-rooms and fitted for burning oil fuel. The hull is subdivided by a double bottom, ten watertight transverse bulkheads and a longitudinal bulkhead on each side of the ship in way of the boiler spaces forming an inner skin. The cargo holds have a capacity of 200,000 cubic feet, and accommodations are provided for 410 first class, 106 second class and 108 third class passengers in addition to a crew of 175.

Empirical Method of Screw Propeller Design

BY PETER DOIG

At the present time there are several well-known first principle theories of propeller action, all of which seem to be practically inapplicable to the problems confronting the naval architect and marine engineer. This unsuitability results from various premises known to be incorrect, *e. g.*, that the blade has no thickness, and that area of blade has no effect. Furthermore, as casual inspection of these theories shows, their basic assumptions are entirely different, the action in the region of the screw being so little known that considerable divergence exists in the opinions of the authorities from whom the theoretical formulæ emanate.

It thus results that the methods of propeller design in vogue are almost purely empirical in their nature. They are of two kinds, which may be described as follows:

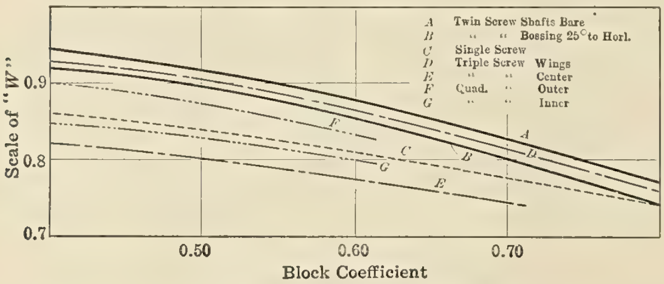


FIG. 1.—WAKE FACTOR (LARGE SHIPS)

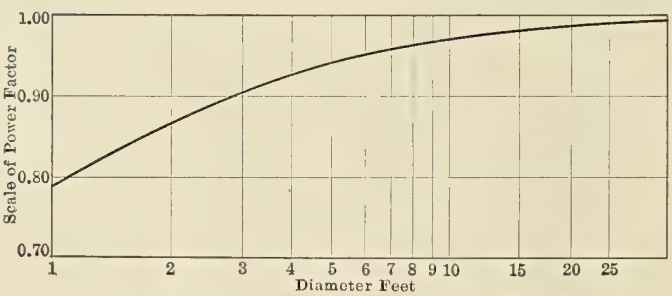


FIG. 2.—POWER FACTOR

(*a*) By comparison with similar ships or—an extension of this method—by generalizations based on the results of full-size practice.

(*b*) By deduction from experiment on models of screws and hulls, relating these miniature results to experience with the full-size ship.

From the first of these it is possible to ensure a fairly good result in most cases, but only when the experience at command is sufficiently comprehensive. And betterment of, or even equality to, past performance must remain somewhat uncertain, an average merit of design being the utmost claimable with skillful and cautious treatment.

The applicability of model experiment rests upon the so-called "Law of Comparison" between the model and the large propeller. From all theoretical considerations of screw action it follows that for a screw advancing with a certain slip, the thrust and torque on the shaft vary as the square of the speed of advance and as the square of the linear dimensions of the wheel. This relation would hold absolutely provided the motions produced in the water around the model and full-size propeller were similar in every respect. Perfect continuity of motion would also be necessary for complete fulfilment, and as this is only possible in a perfect fluid there are resulting dissimilar eddying motions with some departure from the co-called "Law."

For purposes of design, this relation is best formulated that power absorbed varies as the square of dimensions and the cube of the speed of advance. Experiments with model screws at various speeds show that the power absorbed (at a given slip) does vary very closely with the cube of the speed. Moreover, there is practical support of similar trend; for when the results of carefully taken measured mile trials are analyzed, and the slip of the wheel plotted on a base of speed, it will be found that the power driving the ship is varying very nearly as the third power of the speed over any range where the slip has an approximately constant value.

That the power absorbed is nearly proportional to the square of linear dimensions, provided slip and speed are the same, has been shown in the Washington Experimental Basin by a

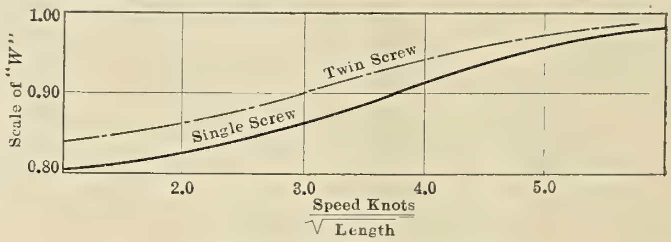


FIG. 3.—MOTOR BOAT WAKE FACTOR

series of experiments on wheels varying only in scale, the diameters being from 8 inches to 24 inches. Some divergence from the law was observed, the larger screws absorbing less power than they should if it were strictly true. Nevertheless, many practical rules have long been in use based on power being absorbed proportionate to the square of the diameter.

True Speed of Propeller Through Water

To test by means of trial data the degree of accuracy of this extension, the real speed of advance of the propeller through the water must be known. In other words, we must be able to connect in some consistent way the speed of the water in the vessel's wake in which the screw works with the speed of the ship. When this can be done the real slip of the screw is computable; and the net power applied to the wheel being known after proper allowance has been made for mechanical losses between the engine and screw, the trustworthiness of the "Law" in question can be gaged and proper power factors found correcting for its divergences from literal truth in extending model experiments to large wheels.

At present the only manner in which the ratio of effective speed of propeller through the wake water to speed of ship can be found is by experiment on models of hull and propellers, as conducted originally by R. E. Froude, and followed up by Pecararo, Luke and others. These investigators have shown that the most important factor influencing the relative speed of the following wake is fullness of ship's form, speed of ship and dimensions and position of screws being, within limits, secondary in importance. Mr. W. J. Luke, of Clydebank, has further shown that when bossed framing and plating are fitted over the outboard part of the shaft the angle of inclination of the webs and the direction of turning of the screws have great influence on the effective speed of the water in the region of the propeller; while with no bossing the direction of turning seems to make little difference on the wake. It appears also from this authority's experiments that generally the best angle of bossing with outward turning screws (*i. e.*, starboard, right hand; port, left hand) is between 20 degrees and 30 degrees to the horizontal. The fittings of bossing cannot be claimed to enhance the efficiency of propulsion to any extent, since the additional resistance due to them seems to wipe out any advantages given to the propeller by their presence.*

Fig. 1 shows the ratios of real speed of screw through water to speed of ship for various arrangements of shaft, all side screws being outward turning. The following notes refer to their derivation and use:

(1) Curves *A, B* and *C* have been well determined by numerous model experiments.

(2) Curves *D, E, F* and *G* apply to all-turbine installations, and were derived by taking into consideration the transverse and fore and aft positions with regard to the hull of the ship and the relatively small diameters of the screws concerned.

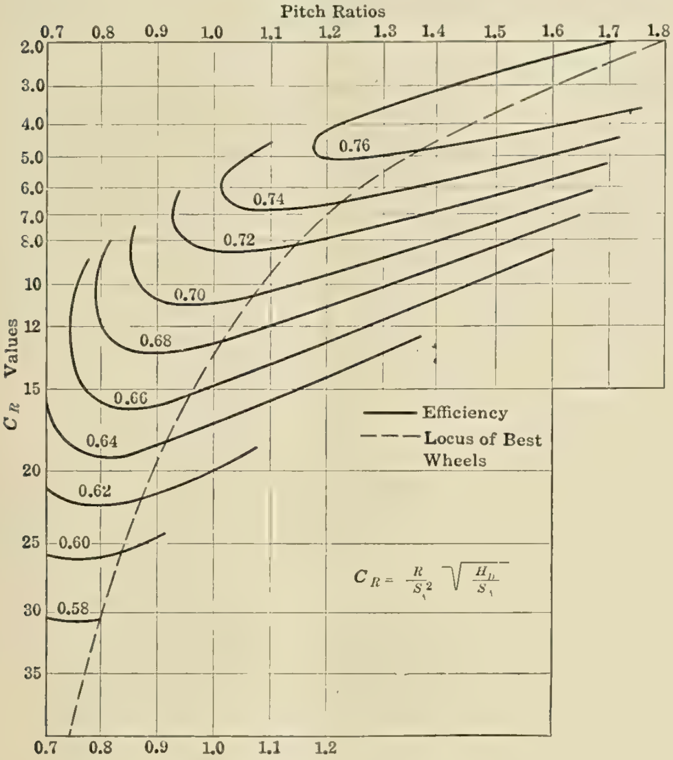


FIG. 4.—CHART FOR PROPELLER DESIGN

(3) It may be noted that a still smaller value of this ratio, *"W,"* than that given by *E* should be taken for the center screw on the exhaust turbine of vessels with reciprocating-engined side shafts, since here the diameter is usually relatively very small. (See Mr. Luke's paper referred to.)

(4) With a fine afterbody form, having the "deadwood" of the ship removed, *"W"* should be increased slightly (about .02 to .03) in curves *A, B* and *C*, the wheels then being relatively clearer from the hull.

(5) The range of speed over which these curves apply may be taken to be from 0.5 to 1.3 speed-length ratio,

$$\text{or} \left(\frac{\text{speed knots}}{\sqrt{\text{length feet}}} \right)$$

In torpedo craft, where the speed-length ratio may be as high as from 1.6 to 2.0, wave phenomena are so excessive as to cause the wake to be negative in direction, the wheels being situated in a trough in which the motion of the water particles is aft. Hence *"W"* is slightly greater than unity, and may be taken:

In triple screw, wings, 1.02 to 1.06; center, 1.00 to 1.03.

In twin screw, 1.00 to 1.05, being greatest with high speeds and cutaway sterns.

POWER ABSORPTION

As thickness of blade is a variable which cannot be related to dimensions alone, the writer has used the results of the experiments on very thin three-bladed wheels, made at the Washington Model Basin and published in 1904. These were upon models 16 inches in diameter with a standard root thickness of 9/32 inch, which is much thinner for the diameter than any propeller in practice, being about one-half to one-third of the usual ratio. Adopting the wake factors of Fig. 1, a factor of power absorption of the thin 16-inch screws compared with full-size wheels was obtained from numerous trial analyses. See Fig. 2. This is made up of two components,

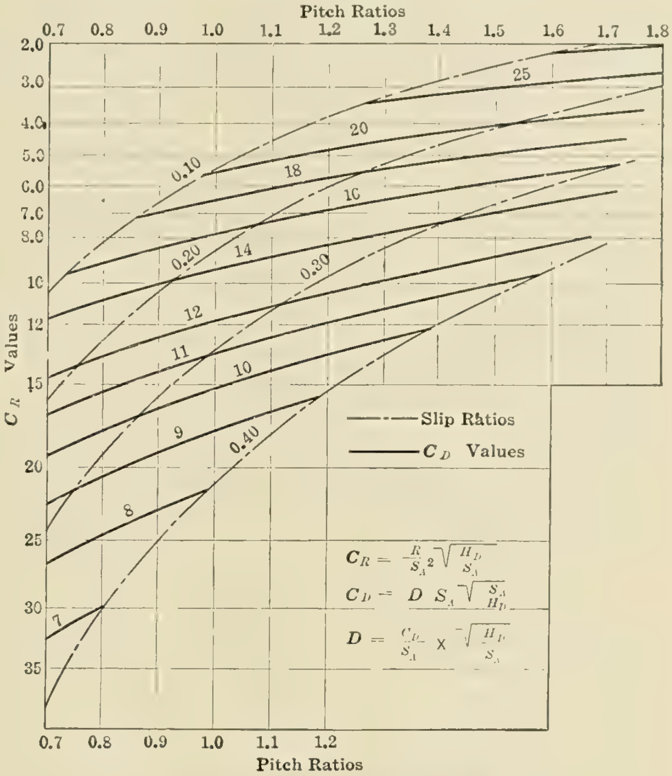


FIG. 5.—CHART FOR PROPELLER DESIGN

representing in terms of power the failure of the "Law of Comparison" and the effect of the greater proportionate root thicknesses of full-size propellers. At the lower end of the curve the former is slight, the effect of blade thickness being predominant. This has been estimated from the Washington experiments on blade thickness, published by Constructor Taylor in his paper "Model Basin Gleanings" (Trans. Soc. Naval Architects and Marine Engineers, 1906).

Fig. 3 gives motor boat and launch wakes as obtained by trial analyses, Fig. 2 being used as the power correction. The base adopted is: speed knots $\div \sqrt{\text{length}}$, which is more readily computed than the coefficients of fineness of these craft; indeed fineness ceases to have any meaning with the hydroplane type, in which the relative speeds on this basis are very high, wake factor being practically unity.

DESIGN OF WHEELS

The variables to be estimated in obtaining the best propeller for a given set of conditions are, in the order of importance:

(1) Diameter.
(2) Pitch.
(3) Surface of blades.
(4) Thickness of blade.
(5) Number of blades.

* A full description of the model experiments concerned, with a resumé of all previous investigators' work, will be found in the memoir by W. J. Luke, Trans. I. N. A., 1910.

(6) Shape of section across blade.

(7) Outline shape of blades.

The present paper proposes to treat only on the determination of the first three of these.

Figs. 4 and 5 are design charts made from the Washington model results referred to above. They are for a standard blade thickness as stated, and also for a ratio of helicoidal blade area to area of disk enveloping blade tips of .40. The coefficients used are:

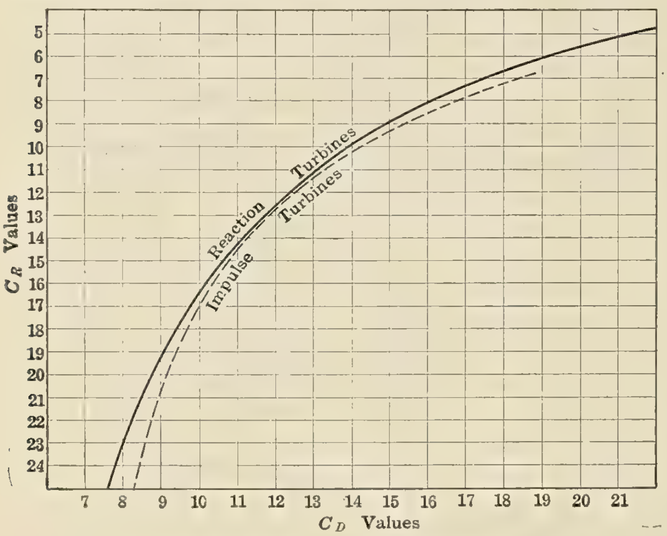


FIG. 6.—CHART FOR DESIGN OF TURBINE PROPELLERS

$$\text{Revolution coefficient } C_r = \frac{R}{S^2_a}\sqrt{\frac{H_d}{S_a}}$$

$$\text{Diameter coefficient } C_d \doteq D\, S_a\sqrt{\frac{S_a}{H_d}}$$

Where R is revolutions per minute.

H_d, horsepower for design (one propeller).

S, speed of vessel in knots.

S_a, speed of propeller through wake $= S \times$ wake factor.

D, diameter of propeller in feet.

The following table gives the ratio of horsepower absorbed by screw to indicated horsepower or brake-horsepower in various types of propelling machinery:

TABLE 1

Type	Multiplier
Reciprocating Engines—	
Attached air, circulating, feed and bilge pumps	I. H. P. × .84
As above without circulating pump	" × .86
All pumps independent	" × .87
High-class engines with high pressures and forced lubrication	" × .88 to .91
Gasoline engines	B. H. P. × .95
Oil engines (on B. H. P. net, *i. e.*, on B. H. P. with deductions for power to compressors or scavengers)	" × .94
Turbines (mechanical loss of 2 percent between point of torque measurement and propeller)	" × .98

On Fig. 4 will be found the experimental efficiencies and pitch ratios (or pitch ÷ diameter) for .40 disk area ratio, also the locus of best wheels for all ships except turbine-driven craft. Fig. 5 shows slips and diameter coefficients corresponding. From these two charts the best diameter and pitch for the standard blade area ratio are obtained. The change in pitch and efficiency for other disk area ratios will be found on Figs. 8 and 9.

In practice with ordinary low or moderate revolutions and power, the best area to use is conditioned by the following considerations. Inspection of Fig. 9 will show that the smallest disk area ratio has the highest efficiency. Hence it

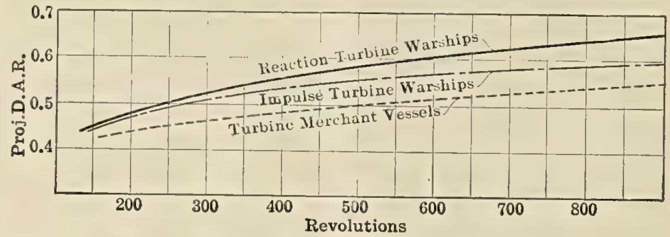


FIG. 7.—GUIDE CHART FOR PROJECTED DISK AREA RATIO

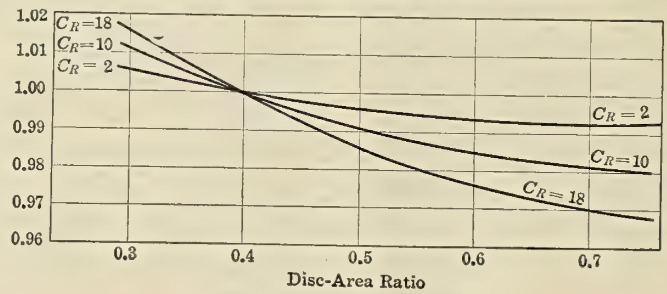


FIG. 8.—PITCH CORRECTION

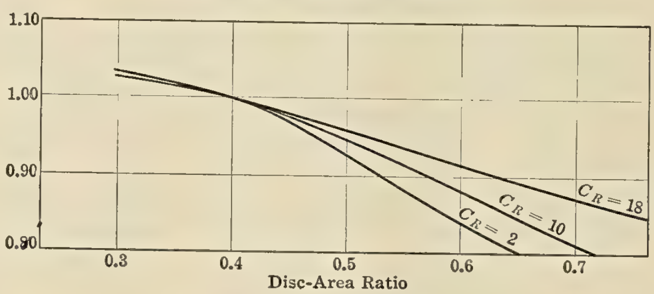


FIG. 9.—APPROXIMATE EFFICIENCY CORRECTION

might be inferred that where there is no danger of cavitation through high-thrust pressures or tip velocities, the lowest disk area ratio should be used. On the other hand, this would entail thicker blades for sufficient strength with the relatively narrow root widths, and a loss of efficiency would ensue. This results in the adoption of moderate area ratios in reciprocating-engined ships, and good practice may be tabulated as below:

TABLE 2

Type of Ships, Etc.	Disk Area Ratio
Single screw full-cargo vessels	.32 to .40
Twin screw cargo vessels	.35 " .40
Liners—twin screw, moderate speed	.35 " .40
Liners—twin screw, high speed	.40 " .45
Battleships and cruisers, twin screw	.38 " .42
Cruising motor boats and steam launches	.35 " .45
Racing motor boats	.50 " .60
Towboats	.50

It should also be noted that Fig. 9 somewhat exaggerates the drop in efficiency with increase in blade area, since the model propellers on which it is based were of uniform thickness for all areas. In other words, other factors being the same, thickness is less the wider the blade, and consequently the decrease in efficiency is probably not so great as shown on the diagram.

Figs. 6 and 7 are based on practice in the design of turbine-driven wheels. Here the proper area or blade width to avoid cavitation is an important consideration, and Fig. 7 shows the average ratios of projected area to disk area, forming a guide chart to the necessary area of blades for varying revolutions. To turn this figure into the developed or helicoidal ratio, the following formula will be found useful for the wide tipped shapes best in wheels liable to cavitation:

$$\frac{\text{Helicoidal area}}{\text{Projected area}} = .80 + .33\ P.\ R.,\text{ where } P.\ R.\text{ is pitch ratio.}$$

To show the procedure in designing from these diagrams, and also their reliability, the writer has taken the published trial results of a number of vessels covering the field of marine propulsion, and designed the best propellers for the trial conditions. The actual wheel fitted is tabulated for comparison.

The requisite area to avoid cavitation can be figured on the basis of thrust per unit of projected surface, as suggested by Barnaby; or by taking into consideration tip velocities as favored by D. W. Taylor and others. It should be noted that Fig. 7 is meant merely as a guide in this particular; but practice will be found to be fairly well represented by it. Barnaby's rule is based on the limitation of thrust pressures to 11¼ pounds per square inch of projected surface with one foot immersion to tips, an additional ⅜ pound being allowed for every extra foot of water over the propeller; but higher values seem permissible. These charts are all for three-bladed screws. An equivalent four-bladed propeller may be found by solving for the best three-bladed one and reducing the diameter 6 percent, pitch and area remaining unaltered. A two-bladed wheel to work at the same revolutions and absorb equal power should have 4 percent more diameter, pitch and area being the same as in the best three-bladed screw.

If the diameter found is too large for draft or clearance, the problem becomes to find from Fig. 5 the pitch ratio suitable for the limiting diameter of propeller, C_d being then fixed.

(*To be concluded.*)

Advantages of Low Ratio of Heating Surface to Grate Area in Boilers

Boiler specifications usually call for a ratio of heating surface to grate area of upwards of 30 to 1, and even as high as 45 or 50 to 1 where forced draft is used. This high ratio of heating surface to grate area naturally means the incorporation into the boiler of a large amount of material, the manufacturing and assembling of which increases the amount of labor involved in building the boiler. It is, therefore, self-evident that the higher the ratio of heating surface to grate area in any given boiler the greater will be the amount of material and labor that goes into the boiler, and as these represent practically all the cost of construction, the first cost or price of the boiler increases almost directly in proportion. In view of the above facts, therefore, it must be accepted as a good policy to keep down the ratio of heating surface to grate area as much as possible consistent with low stack temperatures and the proper absorption of heat by the heating surfaces. This policy has even greater force in the case of marine boilers, as a large amount of heating surface in proportion to the grate area means an increase in the size and weight of the boiler, two factors which it is advantageous to reduce to a minimum in a marine boiler.

The possibility of obtaining better results—that is, the transmission of more heat units from the fuel to the water in the boiler and better evaporation per pound of coal—with a boiler in which the ratio of heating surface to grate area is less than that in the ordinarily accepted type of shell boiler does not seem to be realized by many engineers. By subdividing the heating surface of a boiler into various systems, so that comparatively cool water is brought directly over the fire in the primary generating system and by interposing in the path of the gases a secondary section of heating surface containing water at a temperature of the feed water, the gases of combustion as they proceed toward the stack can be brought in contact repeatedly with heating surfaces containing water at nearly the temperature of the feed water, so that when finally delivered to the stack the temperature of the gases can be reduced to a point far below the temperature due to the pressure on the boiler. In other words, more heat will have been transmitted from a given amount of fuel to the water in the boiler than would be possible in the ordinary type of shell boiler where the temperature of the gases cannot be lowered to a point anywhere near the temperature due to the pressure on the boiler, no matter how great the amount of heating surface put into the boiler. All this can be obtained, moreover, as has been proved by tests and practical experience, with boilers which have smaller ratios of heating surface to grate area than 30 to 1. In fact, a boiler with a ratio of 25 to 1 has shown greater economy, besides occupying less space, having less weight and with a lower center of gravity than boilers with a larger ratio of heating surface to grate area. Furthermore, the boiler of small ratio requires less material and labor and, consequently, less first cost for its construction and smaller maintenance costs for its upkeep.

New British India Liner.—Messrs D. & W. Henderson & Company, Partick, launched recently the screw steamer *Chakrata* of about 5,800 tons gross, which is under construction for the British India Steam Navigation Company, London, for their Eastern trade. The vessel is 420 feet long between perpendiculars, 54 feet 6 inches beam and 31 feet 3 inches depth molded. She is classed 100 A 1 in *Lloyd's Register*, and fulfills the requirements of the Board of Trade passenger certificate. The machinery, which has been constructed by the builders, consists of triple-expansion engines having cylinders 28, 46 and 77 inches diameter and a stroke of 48 inches, supplied with steam at 180 pounds pressure by four single-ended boilers.

Standard Oil Tank Steamer Richmond.—The tank steamer *Richmond*, launched recently by the Fore River Shipbuilding Company, Quincy, Mass., for the Standard Oil Company, is 435 feet long overall, 54 feet beam, 31 feet 6 inches depth, with the hull subdivided into sixteen tanks for carrying 2,250,000 gallons of oil in bulk. The pump room is located forward and the propelling machinery aft. The main engine is a surface-condensing, quadruple-expansion reciprocating engine, with clinders 23, 32¾, 49 and 71½ inches diameter, with a stroke of 51 inches, turning up to eighty-five revolutions per minute. Steam is supplied at a pressure of 220 pounds per square inch by three cylindrical boilers 14 feet 2 inches diameter arranged to burn fuel oil. On a 25-foot draft the vessel will develop 3,000 indicated horsepower, steaming at 11½ knots.

Determination of Stresses in a Vessel's Hull at Sea.—During a recent voyage of the steamship *Ancon*, from New York to Panama and return, an interesting series of tests was made by Mr. James E. Howard, of the Bureau of Standards, Washington, D. C., to determine the magnitude of the stresses set up in the various members of the ship's hull by the pitching and rolling of the vessel, as well as by the vibration of the propelling machinery. This work was accomplished by means of a special strain gage designed to measure elongations down to 1/100,000 of an inch. An outline of the results of this investigation will be published in an early issue of this journal.

The Quadruple Screw French Liner Lutetia

The steamship *Lutetia* is the first mail boat built to the order of the Compagnie de Navigation Sud-Americaine in fulfillment of their contract with the French Government. The keel of the vessel was laid June 18, 1912, and she was launched on March 23, 1913, at the Atlantic yard of the La Société Anonyme des Chantiers et Ateliers de St. Nazaire (Penhouet). The *Lutetia* will be the largest liner running between Continental ports and South America. Her main particulars are: Length over all, 599 feet 5 inches; breadth, 64 feet 3 inches; depth from main deck, 40 feet 8 inches; draft, astern, full load, 23 feet; displacement, 15,600 tons; gross tonnage, 14,400; indicated horsepower, 19,000; speed, 20½ knots. The vessel was launched according to the usual practice at the Atlantic yards; that is, with a double cradle. The ways in this case were 470 feet long and 4 feet wide with a declivity of 6 percent. No drags or chains were used to check the vessel, as there was ample room for the vessel to come to rest before anchoring.

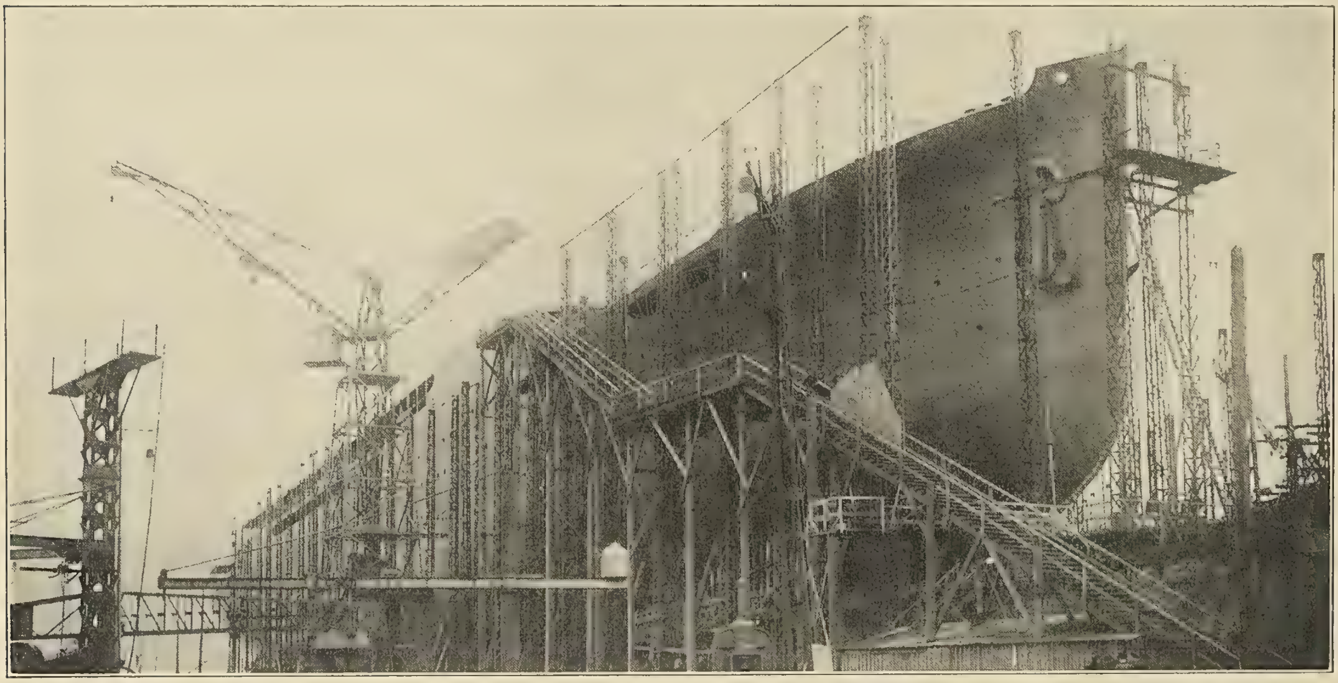


FIG. 1.—FRENCH LINER LUTETIA JUST BEFORE LAUNCHING

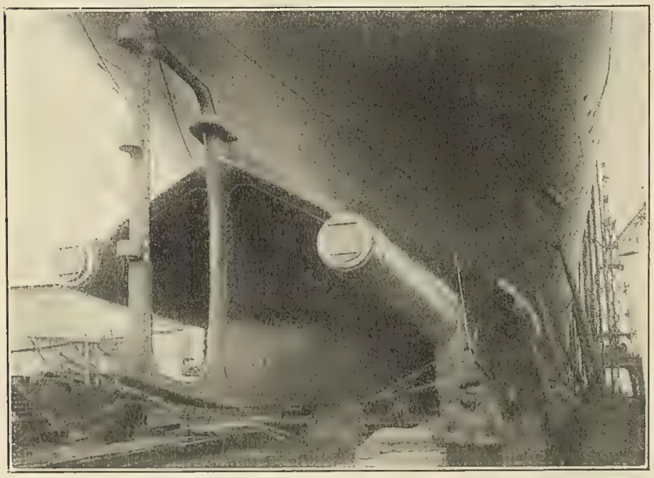


FIG. 2.—STERN VIEW

The hull is built of Siemens-Martins steel throughout. A double bottom has been worked from end to end of the ship, and is divided into ten water ballast compartments having a total capacity of 1,750 tons. The hull is divided into twelve watertight compartments by athwartship bulkheads, three additional compartments being located in way of the boiler and engine rooms. In all twenty-three watertight doors are provided through the bulkheads in order to facilitate the crew's work. These doors are hydraulically operated, and may be closed simultaneously from the navigating bridge. Ballast and special pumps are provided capable of discharging 400 tons of water per hour in case of emergency.

From top to bottom the ship is divided by seven decks, designated, respectively, A, B, C, D, E, F and G, D being the main deck.

Provision has been made for 300 first class passengers, 106 second class, 80 third class and 600 steerage pasengers. The vessel's crew includes 23 officers, 40 deck hands, 133 men for the engine department and 123 pursers, stewards and stewardesses.

All accommodations throughout the ship are heated and ventilated with the latest devices especially designed for use on board ship in hot climates. Three electrically-operated elevators furnish connections to three decks.

Steam at 200 pounds pressure is supplied by eighteen three-furnace cylindrical boilers operated under Howden's system of forced draft. The boilers have a grate surface of 1,210 square feet and a heating surface of 47,000 square feet. The products of combustion are taken care of by three funnels, each 10 feet in diameter and extending to a height of 115 feet above the grate bars.

The propelling machinery consists of a combination of triple-expansion and turbine engines operating four shafts.

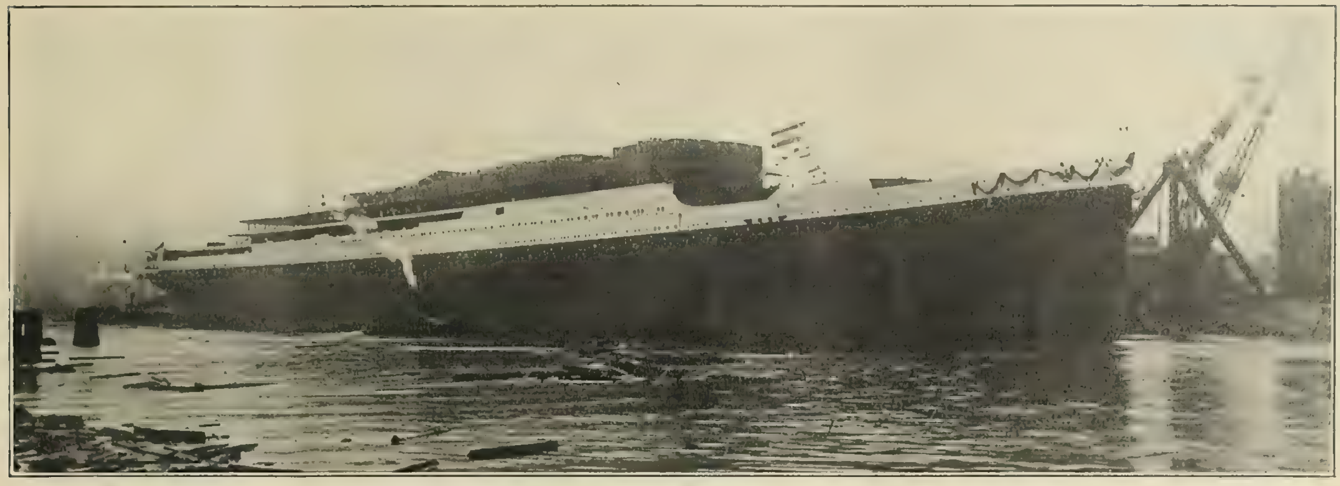


FIG. 1.—HAMBURG-AMERICAN LINER VATERLAND, THE LARGEST VESSEL IN THE WORLD

The reciprocating engines are designed to operate at 105 revolutions per minute, and each engine has four cylinders, 41, 57, 65 and 65 inches diameter, respectively, with a common stroke of 47 inches. When running ahead the main engines exhaust into two independent Parsons low-pressure turbines, working under the reaction principle, the steam being finally delivered into two independent "Contraflo" condensers of 11,000 square feet cooling surface. The practice of installing two reciprocating engines, delivering the steam into two independent low-pressure turbines, was used for the first time in the world by the same builders on the French transatlantic liner *Rochambeau,* and the same type of machinery will be used in the French navy on board the powerful battleships of the *Normandie* class to be laid down during the present year.

The propellers, operated by the reciprocating engines, are 16 feet 5 inches diameter and 23 feet pitch, while the turbine screws are 6 feet 7 inches diameter with a similar pitch. All of the propellers are made of bronze.

The electric plant consists of three dynamos, operated by reciprocating engines, their power aggregating 300 kilowatts at 110 volts. One thousand seven hundred and fifty lamps will be used throughout the vessel.

Launch of the Hamburg-American Liner Vaterland

The steamship *Vaterland,* which is the second of three sister ships of the *Imperator* class now building for the transatlantic passenger service of the Hamburg-American Line, was launched April 3 from the yards of Messrs. Blohm & Voss, Hamburg, the christening ceremony being performed by Prince Rupprecht of Bavaria. While the exact dimensions of the *Vaterland* have not as yet been disclosed, she is reported to be about 4,000 tons larger than the *Imperator.* The propelling machinery, as in the *Imperator,* is a turbine installation aggregating 61,000 shaft-horsepower at 180 revolutions per minute, driving four shafts and designed to give the vessel an average speed of 22½ knots. Accommodations are provided for 4,050 passengers, consisting of 700 first, 600 second, 1,050 third and 1,700 fourth class passengers, which, with a crew of 1,200, will bring the total number of persons on board up to 5,250. The life-saving equipment will consist of eighty-three lifeboats, two of them being motor boats, making provision for more persons than will be carried on board the ship.

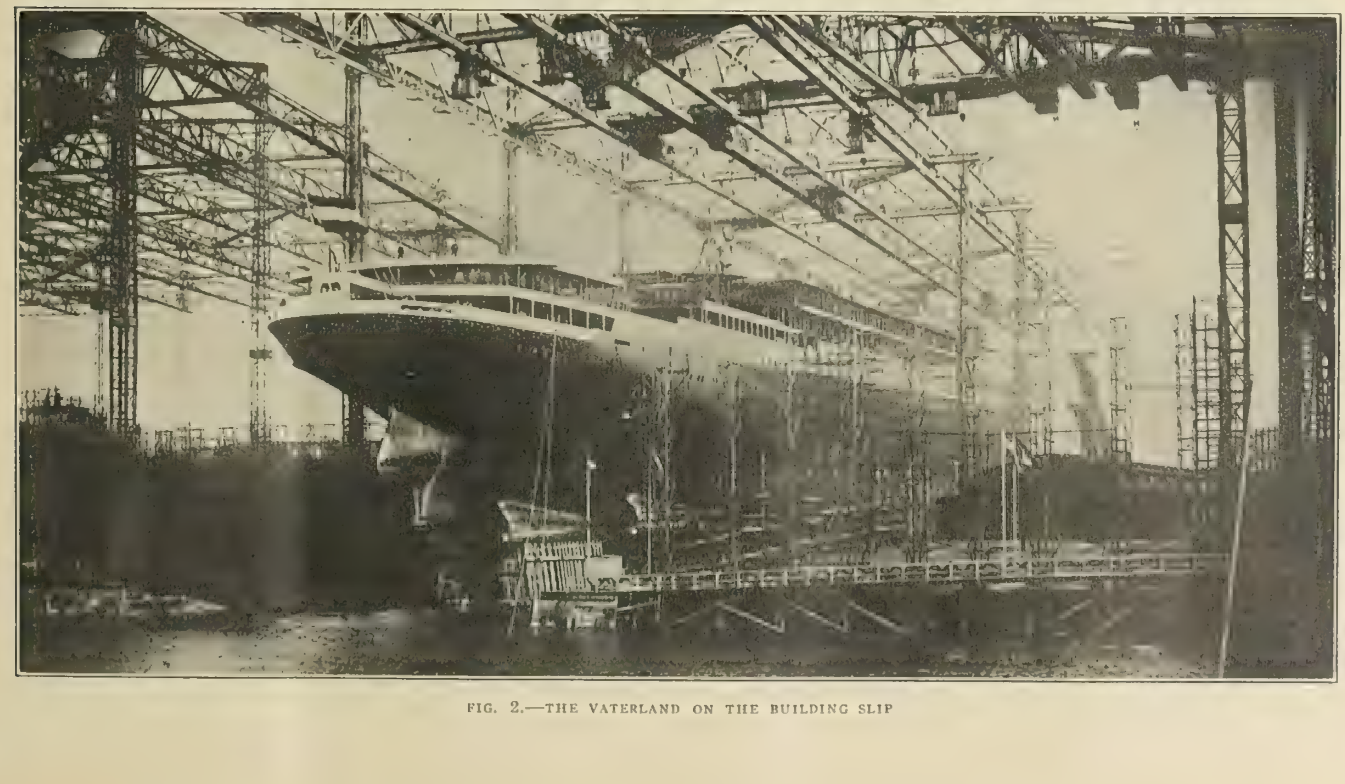


FIG. 2.—THE VATERLAND ON THE BUILDING SLIP

Power Lifeboats—The Lundin Decked Type

Along with the general revival that has taken place during the last few months in the construction and building of lifeboats, a new departure has been entered upon which is of special importance, and that is the adoption of power lifeboats as a part of the life-saving equipment on board passenger ships. Only recently the United States Board of Supervising Inspectors made a new ruling providing that passenger ships hereafter will be permitted to carry a certain number of power lifeboats in addition to the regular lifeboat equipment, and similar rules have been made by the British Board of Trade and foreign governments. The great utility of such equipment in the event of disaster in mid-ocean is now realized as never before from the experience gained in the *Titanic* disaster, and every possible effort should be made by shipbuilders, shipowners and shipping authorities to establish, through the forthcoming International Conference on Safety at Sea, suitable recommendations for adequate equipment of this type.

In considering the installation of power lifeboats, however, there are important questions to be decided; for, although power boats in themselves have been developed to a very high standard as pleasure and commercial boats, yet the problem of providing a power lifeboat brings in new features which have not been of great importance in the ordinary power boat. It is, of course, perfectly feasible to build power boats of any desired size, but when it comes to the handling of such boats on board ship in the event of disaster, and afterwards in a rough sea, there are several reasons why the size of the power boat should be limited.

For guidance in this direction, a valuable lesson can be learned from the life-saving departments on shore, where the equipment has been developed in accordance with natural conditions and from long experience. The length of the average sea-going lifeboat for this service is from 28 to 36 feet, as a boat whose length is within these limits has been found best adapted for handling through surf and in heavy seas. This should be borne in mind when considering the construction of power lifeboats for sea-going vessels, as it is a conclusion reached by experienced seamen after years spent in facing the dangers of rescue work at sea with the sea in its angriest moods.

On the other hand, according to recent proposals made here and abroad, there seems to be a tendency by the authorities and shipowners toward the adoption of comparatively large power lifeboats capable of accommodating from 200 to 300 persons each. The idea apparently is to provide a decked type of boat with accommodations for the passengers below the deck. This would mean, in the case of, say, a 50-foot boat, which could not, without dangerous overcrowding, accommodate more than 200 persons, that the passengers would be packed very closely into a very small space. In fact, in such a boat, allowing for the necessary room forward and aft for lines, releasing gear, engine and wireless equipment, there would be an area in the boat of not more than 2½ square feet per person. By way of comparison, it should be remembered that in an open-decked boat, such as the Lundin decked lifeboat, the passengers, while not sheltered, each have an area of 3¼ square feet when the boat is loaded to its rated capacity.

Moreover, a power lifeboat with two hundred or more frenzied passengers packed into a small space below decks,

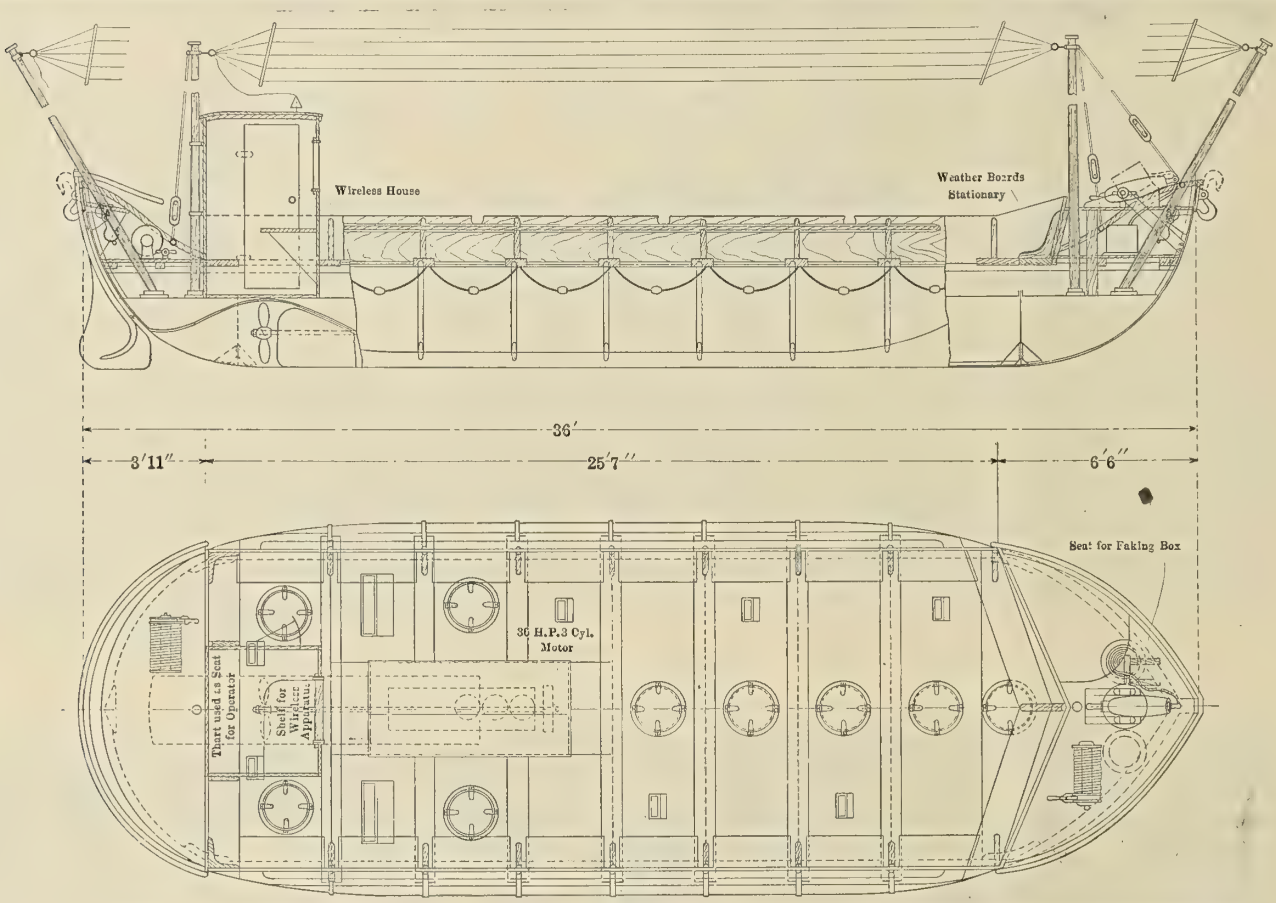


FIG. 1.—LUNDIN POWER LIFEBOAT WITH STATIONARY WEATHER BOARDS, REELS, WIRELESS HOUSE AND EITHER VERTICAL OR SLANTING MASTS

would become practically uninhabitable in a very short time, especially in bad weather. The passengers would instinctively seek the freedom and fresh air on deck even at the risk of exposure to the weather and water, since when on deck they could see what is happening, and would have a better chance to shift for themselves in case of disaster to the lifeboat. A rush to the deck in such a boat, however, would mean one of two things: Either the stability of the boat would be seriously impaired, or, if a few were allowed the freedom of the deck and the rest were compelled to remain below, the passengers would be divided into two classes, with unequal chances of self-preservation, a condition that should not exist in a case of life and death. The possibility of keeping up any kind of order with such a big, and perhaps frenzied, crowd of people, especially if the weather is rough, would be very small. Housed-in power lifeboats should be limited in their capacity to the number of persons that can be carried safely on the deck of the boat.

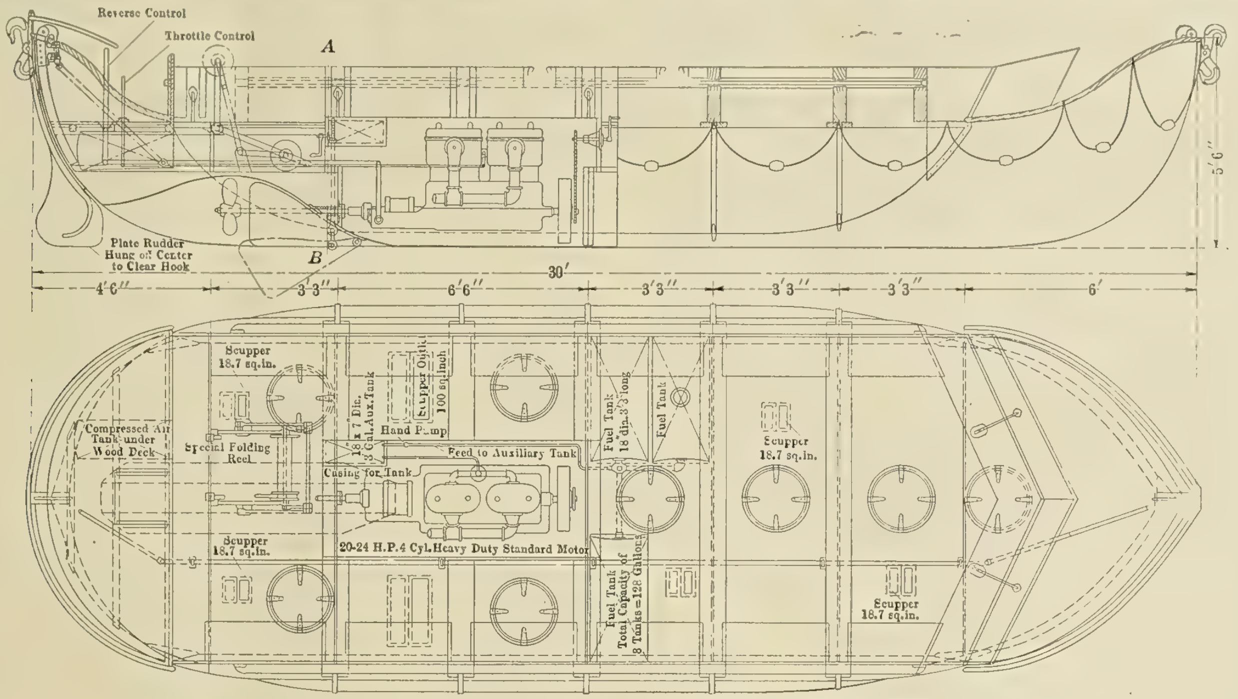


FIG. 2.—LUNDIN POWER LIFEBOAT WITH FOLDING SIDES AND FOLDING REELS

Another most important thing to be considered is that when a power lifeboat is launched over side from a vessel, it is quite unlikely that the engine can be started just as soon as the lifeboat is water-borne. The possibilities and the danger of a delay in starting the motive power of a lifeboat are too great to be ignored; the boat should, for this reason, be small enough and of such a design that it can be handled easily by hand, thus enabling the crew to push away from the vessel and maneuver until the engine is started. A large boat, heavily loaded, would have to depend entirely upon the prompt starting of the engine in order to get away immediately from the side of the ship, otherwise the danger of a collision between the lifeboat and the side of the ship might not be averted, especially on the weather side of the ship.

A large lifeboat, of course, must be very substantially built, including the superstructure or deck portion, which must be sufficiently strong to prevent the sea from smashing it in and washing into the boat; for in that case the danger to the passengers would be enhanced. One has also to remember that the lifeboat, fully loaded, is hanging suspended from only two points when it is handled under davits. A large boat of sufficient strength, however, means an extremely heavy weight to be handled. Such a heavy craft in launching would be exposed to serious damage, for a heavy boat, although built of stronger material than a smaller boat, would, on account of its heavier weight, strike the hull with a far greater and more destructive blow than would a smaller boat. Should an accident occur while launching the boat, the disablement of such a large unit would leave a great number of people wholly unprovided for, even if they were not killed by the accident. On the other hand, with smaller units, such accidents would probably be less likely to happen, and, furthermore, if an accident should occur fewer lives would be imperilled, and there would be a better chance of picking up those who were thrown into the water without seriously overcrowding the other boats.

The use of a large power boat, as we have already re-

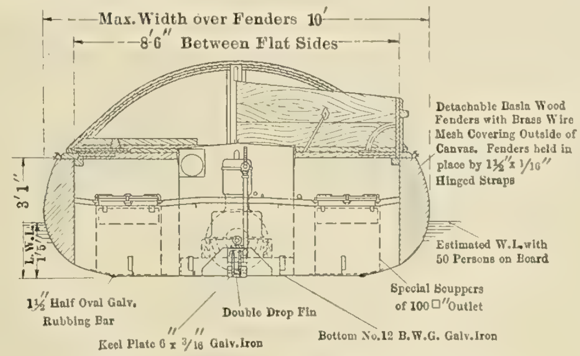


FIG. 3.—SECTION OF LUNDIN POWER LIFEBOAT

marked, involves the handling of extreme weights by the lifeboat launching equipment; for in a strongly-built 50-foot boat, the weight of the boat and the necessary launching equipment would probably average something like 270 pounds per person carried, and this, as compared with only 142 pounds per person for a standard 30-foot lifeboat, or an average of only 110 pounds per person, as is the case with the nested 30-foot Lundin decked lifeboat, under Welin davits, makes it evident that the question of weight of the life-saving equipment per person increases much more rapidly than the capacity of the boat. The weight of the launching equipment which would be necessary to handle the heavy boats is, of course, increased in the same proportion as the whole arrangement, which in turn would mean a substantial reinforcement of the hull and a corresponding addition of weight to the ship.

Judging from the difficulties and dangers which would probably be encountered by using large power boats of the enclosed cabin type as a part of the life-saving equipment on board passenger ships, it would seem to be a much wiser course to use smaller boats of the open-decked type and a greater number of units. If the length of the power lifeboats were limited to a maximum of, say, 36 feet, the obvious advantages of greater safety to the occupants of the boats, together with safer and more rapid handling of the boats, would undoubtedly be secured.

In general there are seven most important and essential features which should be incorporated in a successful power lifeboat, as follows:

I. It should be as nearly uncapsizable as possible rather than a self-righting boat.

2. It should be thoroughly seaworthy, with positive and sufficient self-bailing qualities to quickly relieve itself of any water that might be shipped.

3. It should occupy a minimum height on the deck of the steamship with as great carrying capacity as possible.

4. It should be of such size and form as to be maneuvered by hand when first launched.

5. Means should be readily available for connecting the power boat to the regular lifeboats for towing and for connecting with a rescue ship.

6. It should carry a line-throwing gun to enable it to establish a connection from a stranded ship to the shore.

7. It should preferably have an effective wireless equipment thoroughly protected.

The first feature is of particular importance, as a boat that is practically non-capsizable is the safest boat, even under the worst conditions of the sea, whereas a power boat designed as a self-righting boat does not insure absolute safety against capsizing. If a self-righting boat capsizes, even though it rights itself, and is still of use, yet it is problematical if in a very rough sea the occupants of the boat could save themselves unless they were expert swimmers. The uncapsizable feature, therefore, seems more favorable than any self-righting qualities that might be incorporated.

Seaworthiness, of course, is absolutely necessary, and by seaworthiness is meant the ability of the boat to stand almost any sea and to be readily maneuvered in the heaviest weather. To be thoroughly seaworthy the boat must have positive and sufficient self-bailing qualities to relieve itself quickly of any water that might rush in and at the same time to keep as dry a boat as possible. Where used for transporting people from one ship to another, or in rescue work where a ship is stranded, the need for a seaworthy boat is obvious.

The third feature enumerated—that is, the desirability of keeping the height of the boat as low as possible when placed on the deck of a steamship, and also to have as great a carrying capacity as can be consistent with other requirements—is desirable as far as economizing space in stowing boats on board ship is concerned, and it is also of great importance to have the power boat so built that the propellers, or outward parts of the driving mechanism, are sufficiently well protected to obviate the danger of having them damaged when the boats are handled under davits, particularly if the ship is rolling and pitching.

The importance of the fourth feature is obvious, and has been discussed earlier in the article.

The principal advantage in having a certain number of power lifeboats on board passenger ships is the fact that the regular lifeboats can easily be towed by the power boats and kept together until assistance arrives from some other ship. Power lifeboats can also bring other lifeboats under the lee of the rescuing ship. In either case it is important to be able to make connections between the various boats and also to connect with a rescuing ship, which, in a very rough sea, is not so easily done as might be imagined. It is for such work that feature No. 5 should be provided, and probably the best solution of this problem is the provision of one or more reels of rope on board the power boats, as usually there is not enough rope at hand for towing purposes, and if there is it generally gets twisted and is not in such shape that it can be readily used to the best advantage. If reels of rope are provided the means of connecting the lifeboats together, or connecting to the rescue ship, are readily at hand and instantly available.

The sixth feature needs a little explanation. In the case of a stranded ship it is often found that the distance of such a ship from the shore is too far for the line-carrying guns to reach the shore or vessel. For this reason it would be desirable to have one or more power lifeboats on board the ship equipped with line-carrying guns, so that the power boat can be used as an intermediate station between the wreck and the shore. Such a line-projecting gun would also be useful when it is difficult to make connection with other lifeboats and with the rescue ship.

Wireless equipment, as specified in the seventh feature, must always be in working order to be of any value. So far the difficulties in connection with equipping regular lifeboats with a wireless installation of limited radius have been the impossibility of getting sufficient spread and height for the wires between the masts, and of conveniently housing the operator with the necessary equipment on account of the more or less cramped space that can be obtained on lifeboats. These are difficulties, however, which can be readily overcome. On very large ships, where it is found necessary to carry a great number of power lifeboats, it will probably be found more practicable to carry one power lifeboat on each side of the vessel with suitable wireless equipment.

In view of the importance of the installation of power lifeboats on board passenger ships and the special requirements which such boats must fulfil, both their design and the arrangements for their installation should be made the subject of careful study. In Figs. 1, 2 and 3 are shown plans of a new power lifeboat designed by Captain A. P. Lundin, of the Welin Marine Equipment Company, Long Island City, N. Y.

As can be seen from the illustrations the boat is really a development of the standard Lundin decked lifeboat, which was described on page 252 of our June, 1912, issue. The power boat is provided with a tunnel stern so that the propeller is entirely above the bottom and well protected in the tunnel. The bottom of the hull is absolutely flat; but by a special construction adopted in all types of Lundin lifeboats it is of very great structural strength. The ends are raised, the stern round, the bow being somewhat pointed and shaped off, while the sides are flat. A watertight metal deck is fitted so that the lowest point of the deck is at least 5 inches above the load waterline. The space underneath this deck is subdivided into seven watertight compartments, each fitted with a raised manhole. Thwarts and side benches are fitted on top of the fixed gunwale. The sides above the thwarts are made of wood, and one arrangement is provided with the sides folding to allow nesting and the other with stationary sides. The folding sides are easily raised, and held in position by means of self-locking slides and special corner locks. Smaller boards are fitted athwartships a few feet from each end of the boat, and a couple of rowlocks are provided on each side.

Several small and large sluices are fitted in suitable places through the bottom of the boat, making the boat self-bailing. These sluices are of a special design; the slanting valve is placed beneath the inner bottom, reaching almost down to the load-waterline, with a reservoir to take care of the incoming water, thus making the bailing very effective. The water rushing in through the lower part of the scupper pipe is led in a direction so as to increase the closing pressure of the valve. The valves themselves are placed athwartships, thus making them least affected by the rolling of the boat. This arrangement, it is claimed, gives an unusually dry boat.

Against the flat of each side of the hull is secured a fender, which serves as a protection to the boat and gives additional stability, at the same time shaping out the boat. The two fenders are made of Balsa wood, and are specially prepared so as to make them waterproof. They are covered with heavy canvas, and outside of this with heavy wire cloth, thus making them almost indestructible. They are clamped to the sides of the hull in such a way that they are easily removable for inspection or painting of fenders and hull.

The engine is placed in a watertight trunk with easily detachable covers. Large fuel tanks are placed in the watertight compartment forward of the engine trunk, and are thus beyond reach, out of danger of being hampered with, but at the same time easily accessible when repairs are needed. To improve the maneuvering qualities of the boat in a rough sea a double fin is placed in the forward part of the tunnel. The fin is positively controlled by a gear and screw arrangement, and is designed to make the least resistance in the water, but at the same time is very strongly built, so as to withstand a great side pressure.

The boat with folding sides (Fig. 2) is provided with a folding reel, and the other boat (Fig. 1) with two stationary reels. The boats will in this way be fitted out with at least 1,000 feet or more of good, strong rope conveniently handled. In the bow and the stern of the boat, towing hooks are provided. These hooks are easily handled by means of a special arrangement by which the hook can be made stationary in an upright position. A line-carrying gun with three faking boxes is provided on the boat with stationary sides, and the other boat can be fitted out with a line-carrying shoulder gun.

The boats are equipped with tall masts, and by making them slanting it will be possible to get a length of some 50 feet for the wires on a 36-foot boat, which, of course, means a comparatively big working radius for the wireless. A wireless house is provided on the boat shown in Fig. 1, thus enabling the operator to work without being disturbed in any way. On the boat shown in Fig. 2 the operator will have at his disposal a special arranged working box on the aft deck, so he will be altogether out of the way, and will not be hampered in his operations by the people in the boat. The necessary power for the wireless is furnished by the engine, and the working radius of the wireless would probably be something between 75 and 150 miles, and could be greatly increased by the use of a kit.

As a whole the Lundin decked power lifeboat represents a logical development based upon a wide experience in the building of lifeboats and the construction of tunnel-stern, shallow-draft power boats, two types of craft which combined produce a boat admirably suited to fulfil all reasonable requirements for a successful power lifeboat.

INTERNATIONAL ENGINEERING CONGRESS, 1915.—In connection with the Panama-Pacific International Exposition, which will be held in San Francisco in 1915, there will be an International Engineering Congress in which engineers throughout the world will be invited to participate. The congress will be conducted under the auspices of the five leading American engineering societies.

SHIPBUILDING ACTIVITIES IN AUSTRALIA.—According to press reports, Australia proposes to establish new shipbuilding yards at Jervis Bay, for the construction during the next three years for the Royal Australian navy, of one battleship, three destroyers, two submarines and a supply ship.

MONTHLY SHIPBUILDING RETURNS IN THE UNITED STATES.—The Bureau of Navigation reports 167 sailing, steam and unrigged vessels of 45,397 gross tons built in the United States and officially numbered during the month of April. Forty percent were steel steamships built on the Atlantic coast. The largest vessel built was the *Montanan*, of 6,649 gross tons, constructed by the Maryland Steel Company, Sparrows Point, Md., for the American-Hawiian Steamship Company, New York.

The Motor Ship Siam

The motor liner *Siam*, built by Burmeister & Wain, Copenhagen, for the East Asiatic Company, carried out her trials successfully on April 8. The principal dimensions of the motor ship are: Length, 410 feet; breadth, 55 feet; depth to main deck, 30 feet 6 inches; depth to awning deck, 38 feet 6 inches; draft, 26 feet 6 inches; displacement, 13,200 tons; deadweight carrying capacity, 9,500 tons; capacity of holds, 500,000 cubic feet. The vessel is equipped with two Burmeister & Wain Diesel engines of the four-cycle, eight-cylinder type, developing in all 3,000 horsepower. During the trial trip the fuel consumption amounted to 153 grammes per horsepower-hour, including the main and all auxiliary machinery. A speed of 12.4 knots was obtained.

Besides the main Diesel engines there are two auxiliary Diesel engines installed in the engine room, each of 300 horsepower, coupled to a dynamo and a compressor. The dynamo is large enough so that while running at sea sufficient current is produced to supply all the auxiliary machinery, including the steering engine, as well as for lighting the vessel. When lying in harbor the electric current is used for working the deck winches, which are electrically driven. These winches were supplied by Messrs. Siemens Schuckert, Berlin.

At the conclusion of the trial trip the vessel was taken over by the owners and taken at once to the Freeport, where she took on cargo and commenced her first voyage, calling at Aalborg, Gothenburg and Antwerp for additional cargo, and then proceeding through the Mediterranean and the Suez Canal to Singapore, where her double bottom will be filled with fuel oil, and then she will leave for China and Japan, finally arriving at Vladivostock, whence she will return to Copenhagen. This undoubtedly will be the longest voyage which has yet been undertaken by a motor liner.

Progress of U. S. Naval Vessels

The Bureau of Construction and Repair, Navy Department, reports the following percentage of completion of vessels for the United States navy:

	Tons.	Knots.		Feb. 1.	May 1.
			BATTLESHIPS		
New York	28,000	21	Navy Yard, New York	69.6	77.2
Texas	28,000	21	Newport News Shipb'g Co.	84.3	88.4
Nevada	28,000	20½	Fore River Shipb'g Co.	19.6	29.3
Oklahoma	28,000	20½	New York Shipb'g	14.9	26.0
			TORPEDO BOAT DESTROYERS		
Cassin	742	29½	Bath Iron Works	77.5	87.2
Cummings	742	29½	Bath Iron Works	68.5	81.2
Downes	742	29½	New York Shipb'g Co.	37.1	47.5
Duncan	742	29½	Fore River Shipb'g Co.	63.0	79.0
Aylwin	742	29½	Wm. Cramp & Sons	83.5	92.1
Parker	742	29½	Wm. Cramp & Sons	77.9	89.2
Benham	742	29½	Wm. Cramp & Sons	72.4	87.9
Balch	742	29½	Wm. Cramp & Sons	81.1	88.5
O'Brien	742	29½	Wm. Cramp & Sons	00.0	1.3
Nicholson	742	29½	Wm. Cramp & Sons	00.0	1.2
Winslow	742	29½	Wm. Cramp & Sons	00.0	1.2
McDougal	742	29½	Bath Iron Works	00.0	4.4
Cushing	742	29½	Fore River Shipb'g Co.	00.0	8.9
Ericsson	742	29½	New York Shipb'g Co.	00.0	5.0
			SUBMARINE TORPEDO BOATS		
F-4	....	....	Seattle Con. & D. D. Co.	94.6	100.0
G-4	....	....	Wm. Cramp & Sons	88.3	88.4
G-2	....	....	Newport News Shipb'g Co.	86.0	87.2
H-1	....	....	Union Iron Works	87.2	90.4
H-2	....	....	Union Iron Works	86.7	90.0
H-3	....	....	Seattle Con. & D. D. Co.	84.9	88.0
G-3	....	....	Lake T. B. Co.	61.9	67.4
K-1	....	....	Fore River Shipb'g Co.	65.5	76.6
K-2	....	....	Fore River Shipb'g Co.	65.3	76.8
K-3	....	....	Union Iron Works	68.1	75.6
K-4	....	....	Seattle Con. & D. D. Co.	66.1	75.0
K-5	....	....	Fore River Shipb'g Co.	48.5	58.7
K-6	....	....	Fore River Shipb'g Co.	48.5	57.1
K-7	....	....	Union Iron Works	55.6	65.3
K-8	....	....	Union Iron Works	54.1	63.4
			COLLIERS		
Proteus	20,000	14	Newport News Shipb'g Co.	80.4	90.7
Nereus	20,000	14	Newport News Shipb'g Co.	72.1	87.1
Jason	20,000	14	Maryland Steel Co.	87.2	98.8
Jupiter	20,000	14	Navy Yard, Mare Island	92.5	99.1

Side-Wheel Passenger Steamer See-and-Bee

The new side-wheel passenger steamer *See-and-Bee*, built for the Cleveland & Buffalo Transit Company, Cleveland, Ohio, at the Wyandotte yard of the Detroit Ship Building Company, was launched Nov. 9, 1912, and will be ready July 1 for daily service between Cleveland and Buffalo. The vessel, designed by Frank E. Kirby, is not only the largest side-wheel passenger steamer on the Great Lakes, but is also the largest side-wheeler in the world. Her construction marks a notable achievement in naval architecture for this class of vessel, and establishes a standard that it is quite unlikely will be exceeded for a long time to come. The steamer is of the following dimensions:

Length over all	500 feet.
Length between perpendiculars	485 feet.
Beam of hull, molded	58 feet.
Extreme beam over guards	97 feet 8 inches.
Depth of hull at stem	30 feet 4 inches.
Depth of hull at stern	27 feet 1 inch.
Depth of hull, molded	23 feet 6 inches.
Depth of hull at guards	22 feet 10 inches.

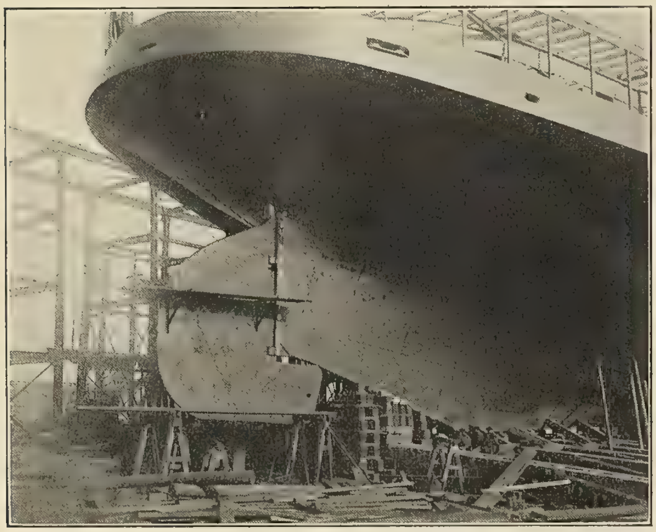


FIG. 1.—STERN OF HULL

FIG. 2.—BOW RUDDER

Her guaranteed speed is 22 miles per hour from dock to dock, and to make it she has been equipped with propelling machinery developing 12,000 horsepower.

There are 62 staterooms fitted with private toilet connections, 424 regulation staterooms and 24 parlors *en suite* with private bath and toilet, making a total of 510 rooms. She has therefore sleeping accommodations for 1,500 persons, and will carry about 6,000 passengers, the population of quite a respectable sized town. Her freight capacity is 1,500 tons, carried exclusively on the main deck for convenience of handling.

Decorative Features

The keynote of the decorative scheme, worked out by Louis O. Keil, is a rich simplicity. The first thing that the traveler sees, of course, about a steamer is the lobby. This is very spacious, containing the purser's and steward's offices, telephone booths, parcel and baggage rooms, and a lunch counter, the entrance of which is gained through a doorway. The lobby is designed in the Tuscan order of architecture. The walls are paneled in mahogany inlaid with various woods, and the colors are in keeping with the general dominant tone of this aristocrat of woods. The ceiling decorations are in bronze and Roman verd. A feature of the lobby that marks quite a departure from the usual sidewheelers on the lakes is that the grand stairway leading to the promenade deck is enclosed in a vestibule with sliding doors. The purpose of this is to shut the stairway off immediately if occasion requires.

The main dining room is immediately abaft the purser's and steward's offices, on the main deck, extending to the stern of the ship. It is carried out in Adams design with mahogany and white enamel. In addition to a banquet room 24 feet long on the starboard side and two private dining rooms on the port side, there are a number of alcoves with bay windows on both port and starboard sides of the main room, where one may have a fair degree of privacy in dining. Light is obtained from Sheffield silver candelabra carried on columns, as well as Sheffield silver wall brackets. The extreme outer end of the main dining room is taken up with a great sideboard with dumb waiter leading to the buffet on the orlop deck below. The location of the dining room on the main deck is a happy one, as it permits the passenger to look out over the waters as the boat speeds along.

The buffet, as stated, is directly under the dining room, and is approached by a stairway on the main deck aft. It is in tavern design after the manner of an old English inn, and will call to mind the remark of the great Dr. Samuel Johnson that nothing was ever contrived that gave mankind so much creature comfort as a good tavern.

Passing from the lobby to a vestibule and up a wide and handsome flight of stairs one enters the main saloon, upwards of 400 feet long, on the promenade deck, and subdivided for convenience into several sections, having flower booths, a book and periodical store, observation room and ladies' writing room amidships and men's writing room forward. The style of the main saloon is in the Ionic order of architecture, having a wainscot of carefully selected mahogany highly furnished, the upper part finished in fine enamel.

The general color scheme of the gallery deck is gray, ivory and white. At the after end of the gallery deck is the ladies' drawing room of Italian Renaissance design with built-in seats at the after end in walnut. The furniture in this room is of walnut covered in tapestry, and the floor covering of the best Wilton. The room is lighted by ceiling fixtures.

On the upper deck, immediately above the drawing room, is located the atrium, which is a Pompeiian court with sleeping rooms adjoining. In the center is an open well looking down upon the drawing room. A balcony for an orchestra is located at the after end of the main saloon, just forward of the ladies' drawing room on the gallery deck above, from which music reaches not only the main saloon but the drawing room and atrium on the upper decks as well.

Probably the most popular feature of the ship will be the lounge on the upper gallery deck amidships. It will be conventional in design, finished in fumed oak, and the decorative features in L'Art Nouveau are painted directly on the wood. The stack casing which penetrates this room is decorated by panel paintings. This room may also be reached by a forward stairway leading from the promenade deck between the stacks to the upper deck. An air of comfort and coziness is imparted to the lounge by numerous little bays on both the port and starboard sides, where light refreshments are served from a counter built-in at the after end of the lounge. The floor is covered with asbestolith.

FIG. 3.—THE ATRIUM

FIG. 5.—MAIN SALOON

FIG. 4.—THE LOUNGE

FIG. 6.—MAIN DINING ROOM

Bordering the main saloon are a number of parlors, the principal ones being named by courtesy in honor of the president, general manager, traffic manager and directors of the company. Each room is of different design, being finished in either vermilion wood, satin wood, mahogany, red gum wood, silver gray maple, prima vera and enamel. The furniture and decorations of each of these parlors is in keeping with the character of the wood finish. Each parlor contains twin brass beds, a divan, tables, dressers, chairs, mirrors and plenty of cushions to lend an air of comfort. Private baths, finished in pure white enamel, and private balconies complete the equipment of these parlor suites.

Hull Structure

The hull is constructed entirely of steel, having a double bottom for water ballast extending for a length of about 365 feet, and having a depth of of 3 feet above the base line. This double bottom is divided at the center line by a fore-and-aft watertight girder, and is further subdivided by transverse bulkheads into fourteen separate watertight compartments. The hull above the water bottom is divided by eleven athwartship watertight bulkheads extending from the keel to the main deck. These watertight bulkheads, with the exception of the collision bulkhead and other bulkheads that are required by law to be without openings, are fitted with watertight doors operated hydraulically from the engine room.

Including the tank top there are seven decks in all, namely, the orlop deck, main deck, promenade deck, gallery deck, upper deck and dome deck.

Steel is used to a greater extent in the structure of this ship than in any other of her type, being carried to the

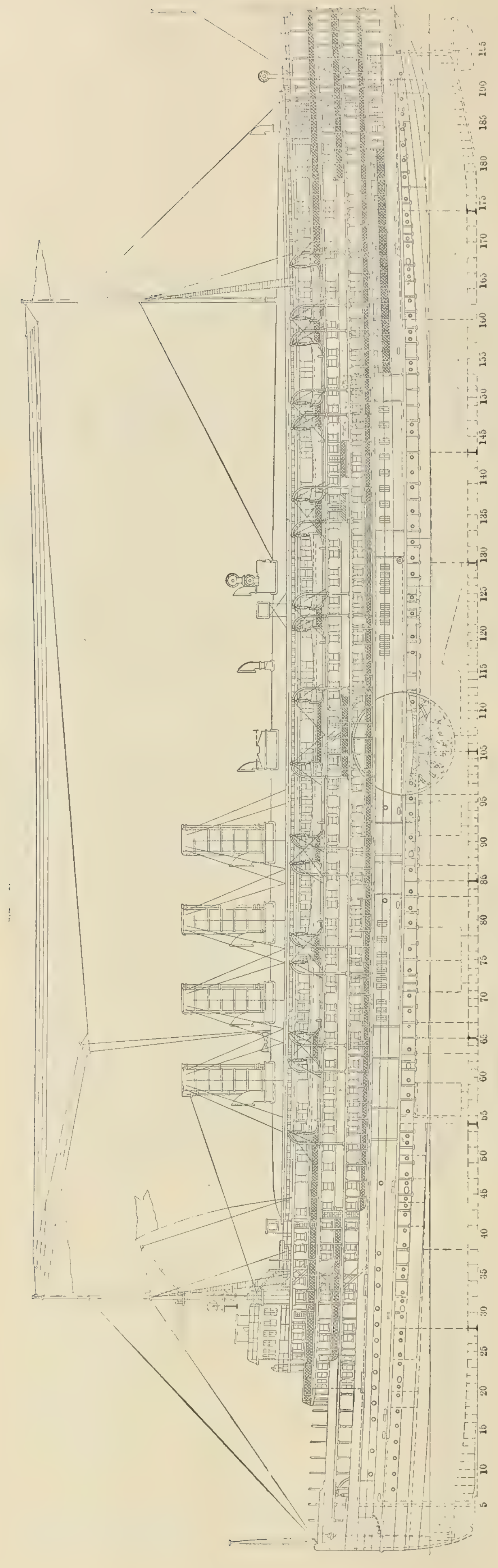


FIG. 7.—OUTBOARD PROFILE OF THE SEE-AND-BEE

promenade deck. The housings on the orlop and main decks and top sides to the promenade deck are of steel. The top sides of the promenade deck are finished with a channel gutter, forming a landing for the promenade deck beams. The beams and the underside of the promenade deck are sheathed with galvanized iron with heavy asbestos paper. This with the steel housings up to the promenade deck makes the vessel practically fireproof. Moreover, the engine room, boiler room and galley, ventilators and inclosures are all of steel, and extend from the main deck through the top of the dome. Fireproof doors are also fitted extending from the main deck through all decks to the dome, dividing the vessel into three separate compartments.

In addition to the three great divisions the boat is divided into fifty sections for fire alarm purposes, each section containing about eight staterooms, and by means of a very ingenious device of hollow wire with which each stateroom is equipped, any disturbance will be immediately registered upon an annunciator located in the engine room and in the captain's quarters.

The crew's quarters are built of steel throughout. Steel fire curtains are fitted in cargo spaces opposite engine room inclosures. Fire hydrants are located throughout the vessel, so spaced that 50-foot lengths of hose connected at all times reach every part of the vessel.

There is also a very complete automatic sprinkler system throughout the interior of the ship, covering all cargo holds, crew's spaces, hallways and cabins, smoking room, lounge room, and other service rooms of the ship. This system is controlled automatically by a special sprinkler pump located in the engine room. When the vessel is docked connections are also made whereby city protection for fire purposes can be immediately used.

There are two trimming tanks, each of about 52 tons capacity, located on both port and starboard sides just aft of the wheel casings. These tanks can be either filled or emptied in from two to four minutes, thus making it possible to keep the vessel always on an even keel.

To facilitate quick handling in rivers and harbors, the steamer is fitted with a bow rudder, which is controlled by a steam steering engine located on the main deck forward and directly connected to rudder stock by chain and quadrant. The character of the service is such that the vessel has to navigate restricted and somewhat tortuous channels at both Buffalo and Cleveland, and the bow rudder makes her instantly responsive and manageable. The after rudder is controlled by a steam steering engine connected to quadrant by a chain. Emergency steam steering gear is also provided should anything go wrong at any time with the after rudder.

The life-saving appliances of the vessel are in accordance with Government requirements, there being eighteen metallic lifeboats, all of special design, fourteen of these having a capacity for forty persons each, two having a capacity for twenty persons each, and two for sixteen persons each. In addition the vessel is equipped with the usual number of life rafts and life preservers, as required by the United States Steamboat Inspection Service.

The second class cabins, both for men and women, are built entirely of steel, and are located on the main deck forward of the lobby.

Great attention has been paid to the ventilation of the ship, which is equipped with the latest type of McCreery Engineering Company's washed air system of ventilation, reaching all inside staterooms, dining rooms, buffet, smokeroom, galley and crew's spaces. This system of ventilation is also directly connected to all lavatories and toilet rooms throughout the ship, and is divided into five units, as follows: One unit forward in the hold will supply the crew's quarters for that end of the ship; one unit in the hold directly aft of

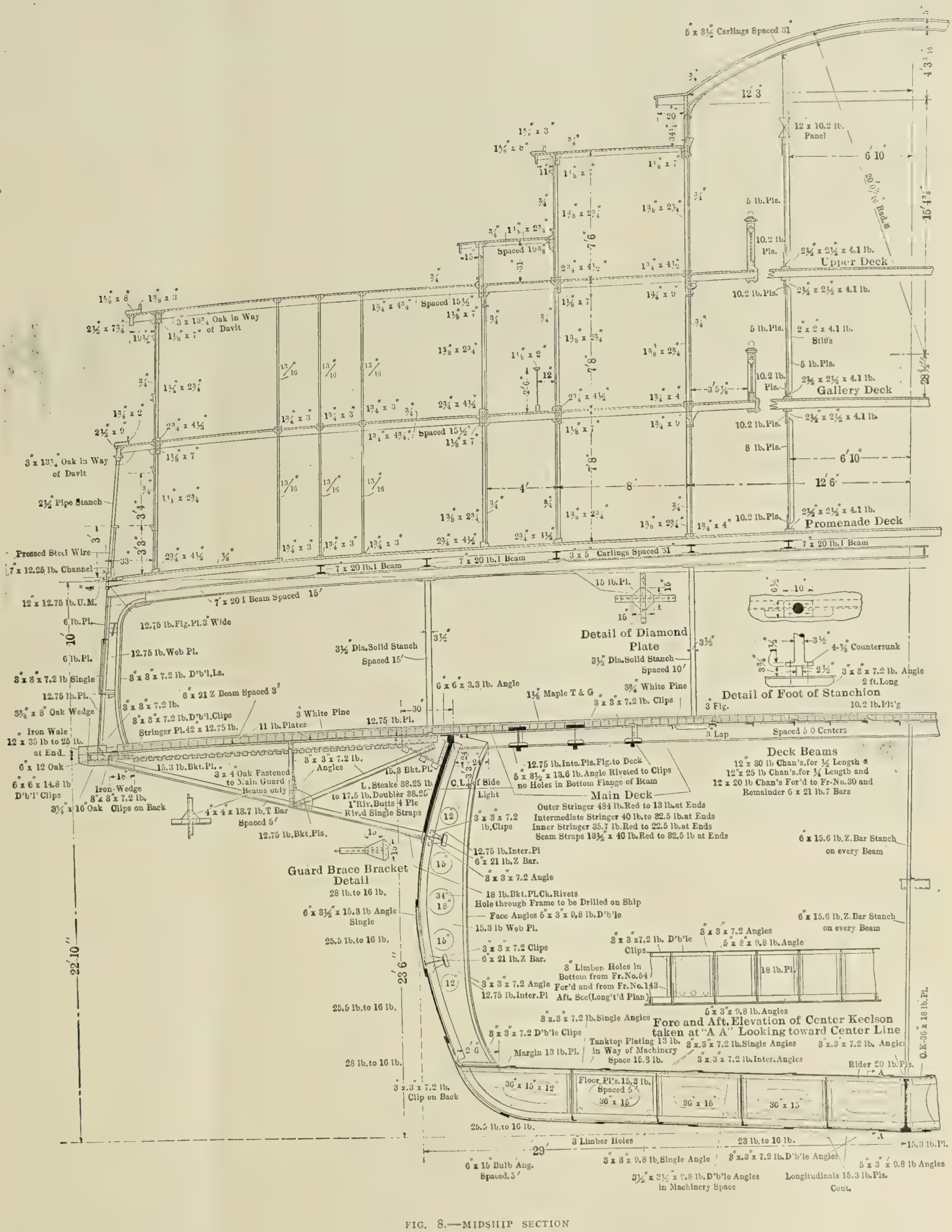


FIG. 8.—MIDSHIP SECTION

the engine room will supply the crew's quarters aft and the galley; one unit located on the orlop deck aft will supply the dining room and two units on the main deck, port and starboard will supply all the staterooms, the baggage room, the telephone room and second class deck cabins.

These units consist of a McCreery air washer built of heavy sheet copper with brass angle and brass pipe work. A Sirocco fan direct connected to an electric motor draws the air through a washer and distributes it through the duct work. The spray in the washer is maintained by a centrifugal pump direct connected to an electric motor. Throughout the crew's quarters and galley adjustable elbows are used for distributing the air, making it possible to deliver the air in any desired direction. The air in the staterooms is introduced underneath the lower berths in such a manner and in such velocity that no draft is felt in any part of the room. The lower berth is kept out from the wall at least an inch, so that the air flows directly upwards entirely around both berths. A space between two carlines is closed off, and is provided with a hinged door at both the side wall of the inside staterooms and the outside of the cabins. This provides a natural exhaust from the rooms to the outside of the ship.

The heat generated in the galley and the foul air from the crew's quarters aft are removed by a large Sirocco fan located in the galley vent and connected to the spaces to be ventilated by means of duct work. Approximately 60 horsepower is used for the ventilating system. The local vents from all the toilet fixtures throughout the ship are connected by means of duct work with aspirating tubes in two of the stacks, thus maintaining a positive exhaust of considerable suction on all these fixtures, so that no possible odors escape into the ship. This is a very important feature, as a large number of toilet fixtures are installed with parlors and semi-parlors.

Propelling Machinery

The propelling engine is of the inclined, three-cylinder, compound jet condensing type, installed in a compartment by itself immediately aft of the boilers, having one high-pressure and two low-pressure cylinders, each low-pressure cylinder having a large receiver built of plate steel directly overhead. The estimated indicated horsepower is 12,000 at 31 revolutions per minute. Practically the entire engine is under the main deck, only the tops of the main bearings, the upper part of some of the valve gear and the handling levers projecting above the level of the deck. The high-pressure cylinder is 66 inches in diameter, and is placed between the two 96-inch diameter low-pressure cylinders, all having a common piston stroke of 9 feet.

All the cylinders were molded on end in loam molds. The open end was cast down, this being the usual practice of the makers. The mold was parted on the center line of the steam chests, also in the center line of the cylinder, and drawbacks were made on the upper steam chests. These partings were made to enable setting of the cores with greater accuracy. The radial cores for the crank end of the cylinders were suspended from the top plate of the mold and the center of main core was put in place last. The contract called for 30,000 pounds tensile strength, but all test bars showed better than the requirements. The rough castings of one low-pressure cylinder weighs 65,760 pounds, and the other 67,200 pounds. The high-pressure cylinder weighs 54,000 pounds.

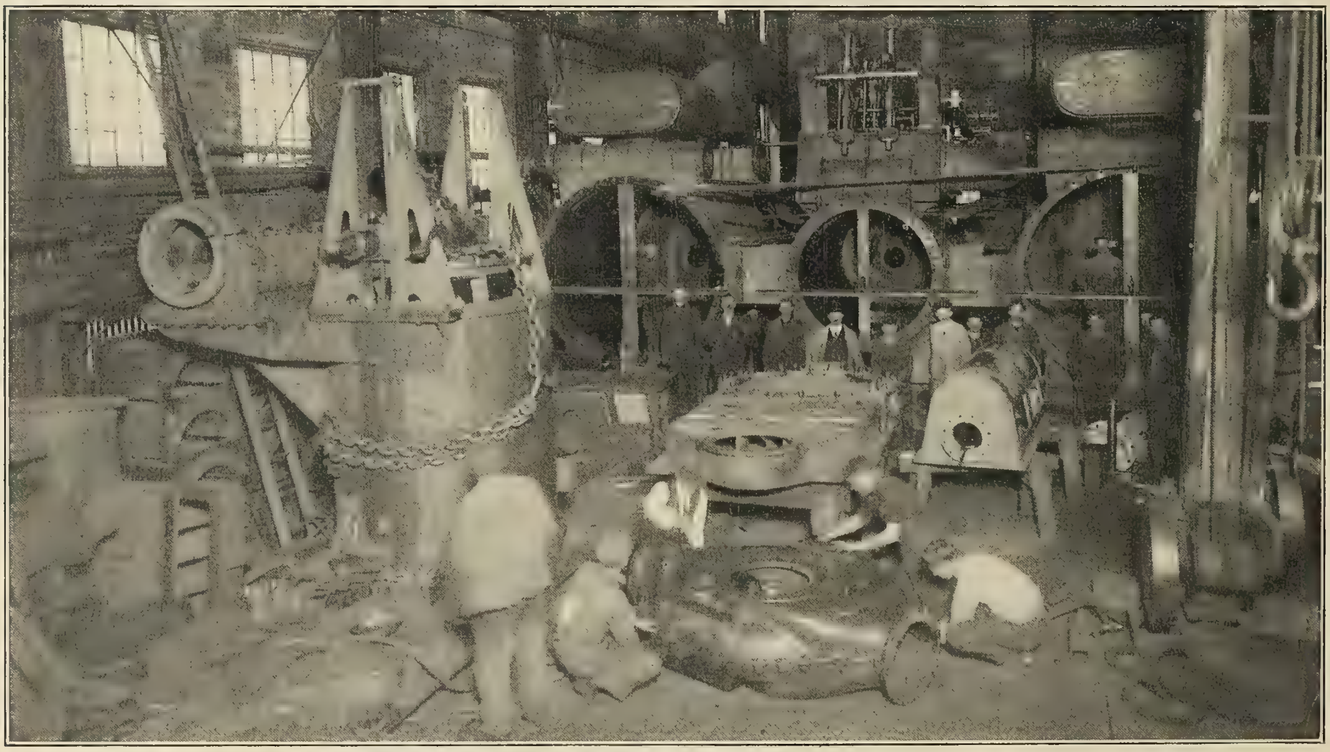


FIG. 9.—MAIN ENGINE ON ERECTING FLOOR OF BUILDER'S SHOP

The high-pressure cylinder is fitted with poppet valves and Sickles cut-off gear, while the low-pressure cylinders have Corliss valve and gear. The valves are all operated by the Walschaert gear so familiar on locomotives. This, in combination with the poppet gear on high-pressure and the Corliss on the low-pressures, is unique in marine design. The principal reason for adopting this gear was the desirability of one eccentric on the main shaft for each cylinder and the advantage of short eccentric rods, also that the links take up less head room. The cut-off in each cylinder has a range of from one-fourth to three-fourths of the stroke, adjustable from the starting platform.

None of the cylinders is steam jacketed, but, together with the two large tank receivers, all are well insulated. The pistons are of cast steel, conical and of single thickness, and are fitted with cast iron spring and junk rings. The piston rods, crossheads, connecting rods, guide struts and crankshaft

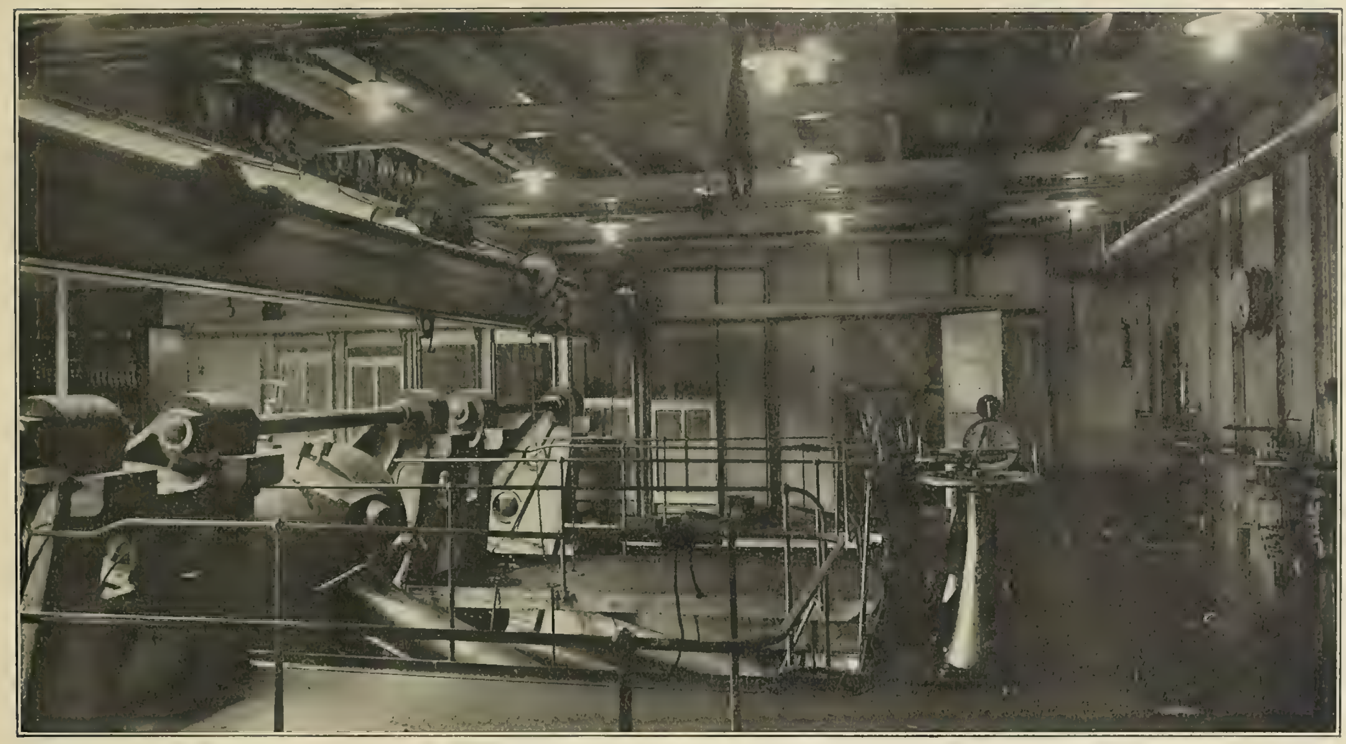


FIG. 10.—VIEW IN ENGINE ROOM, SHOWING STARTING PLATFORM

are all of the highest quality steel forgings, supplied by the Midvale Steel Company. The crankshaft is 26¾ inches in diameter in the engine bearings and 30¾ inches in diameter at the outer bearings, 78 feet 4 inches long from end to end, and weighs 120 tons, and is of carbon steel, hollow forged. It is made in three sections, connected by flanged couplings, which are recessed into the hubs of the crank arms. The crank arms are sunk into the pins, thus making the crank-

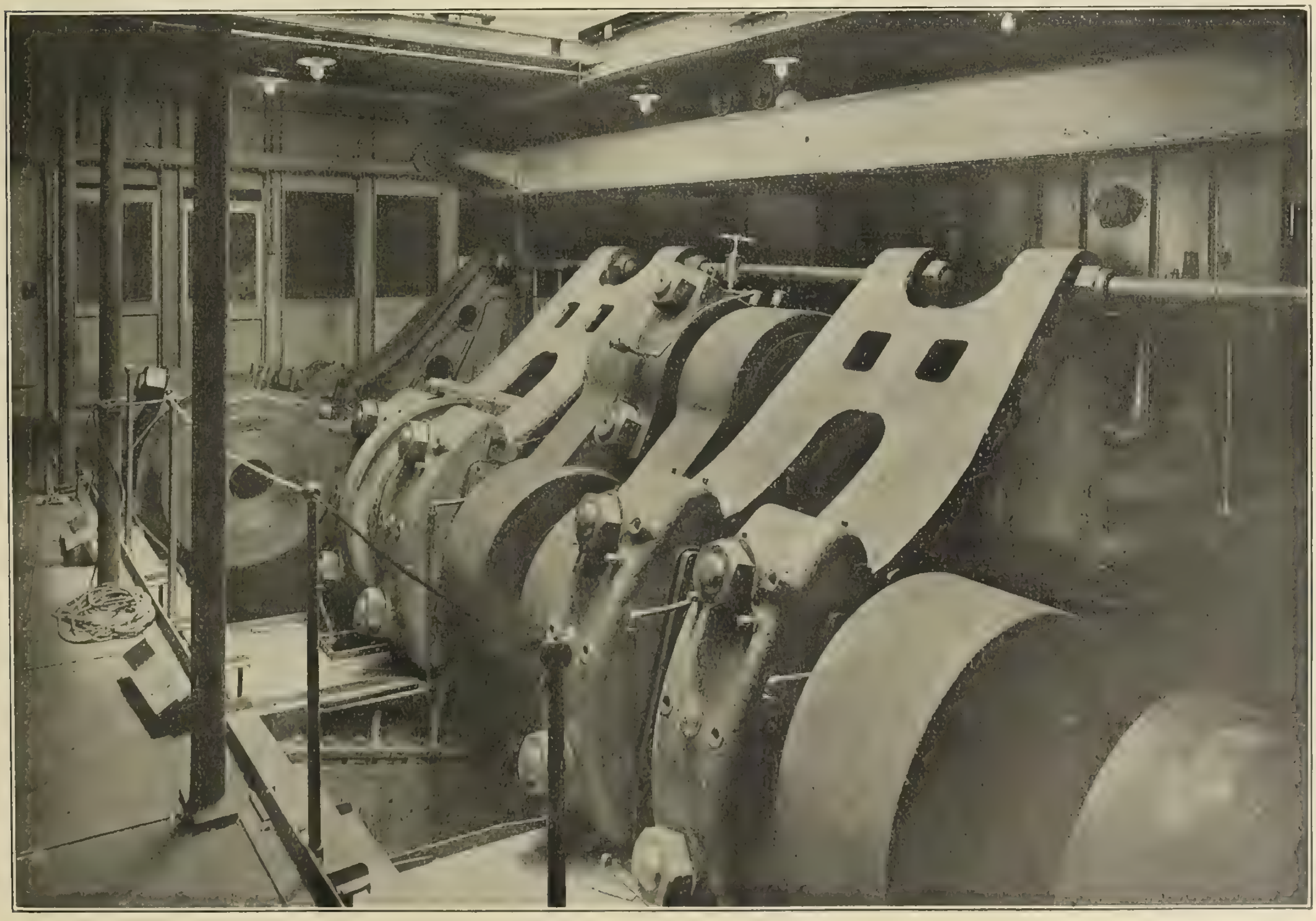


FIG. 11.—MAIN ENGINE CRANKSHAFT AND PILLOW BLOCKS

shaft perfectly rigid from end to end, and avoiding all the trouble incidental to loose pins, wedges, etc. The crank-shafting and pins are hollow throughout.

The connecting rods are 21 feet 2 inches center to center, and 15 inches in diameter at the center of their length, and are nickel steel. Each connecting rod weighs approximately 12 tons. The piston rods are 12½ inches diameter, and the crosshead slippers are steel castings faced with white metal. The main bearing pedestals, six in number, are massive steel castings, rigidly bolted to the foundations, which are part of the ship structure, and braced together to insure stiffness when the engine is working. The guide struts are connected to the main bearing castings by a T-end, through which the main bearing bolts are extended, and to the cylinder by round flanges and bolts. Midway in their length they are supported by vertical columns carried from the ship's floors. Each cylinder, as stated, is cast complete with its valve chests, thus avoiding all unnecessary and oftentimes troublesome joints. The front heads are also cast with the cylinders, and are strongly ribbed to distribute the strain from the guide struts. The finished low-pressure cylinders weigh 33 tons each, and are excellent specimens of the founder's art.

The main air pumps, 62 inches diameter by 41½ inches stroke, two in number, are of the vertical, single-acting plunger and bucket type, driven through heavy forged steel bell crank levers from the low-pressure crossheads. Each air pump crosshead also carries the plunger of a single-acting vertical feed pump, 8 inches by 41½ inches, and bilge pump 7 inches by 41½ inches.

The condensers are built up of riveted plate, and each low-pressure cylinder connects with its own condenser through a 24-inch exhaust pipe.

The reversing of the engines is accomplished by means of a direct-acting steam gear, but a powerful hand-operated worm reversing gear is fitted for emergency use.

The handling gear levers are all conveniently grouped in a quadrant on the working platform above the cylinders, and massive though the moving parts are the reversing, etc., is accomplished with the greatest ease and facility. The main throttle valve, 18 inches in diameter, is of the Schuette-Koerting balanced type, operated by a simple lever, and is fitted with an 8-inch "by-pass," or maneuvering valve, which is sufficiently large to operate the engine up to half speed. The lubricating system is elaborate and complete, as are the appliances to assist in the overhauling or lifting of the engine parts. The paddle-wheels are unusually strong and heavy. The centers are of cast steel and the arms of forged iron, with the large gudgeon bosses forged on and bushed with lignum-vitæ. The wheels are 32 feet 9 inches diameter, each fitted with eleven curved steel buckets, 14 feet 10 inches long by 5 feet wide. The radius rods are of forged steel fitted with brass bushings. The outboard bearings are heavy steel castings, lined with white metal, and are adjustable in vertical and fore-and-aft directions.

Boilers

Steam at 165 pounds per square inch pressure is supplied by six single-ended and three double-ended Scotch boilers. The single-ended boilers are made up of two shell plates, and are 14 feet inside diameter by 10 feet 6 inches over head, and each contains two 54-inch inside diameter Morison plain-end furnaces; the tubes are 2¾ inches outside diameter. The double-ended boilers are made up of only four shell plates, and are 14 feet 2 3/16 inches mean diameter by 20 feet 5½ inches over-heads, and each containing four 54-inch inside diameter Morison suspension plain-end furnaces. The tubes are 2¾ inches outside diameter. The grate bars are all 5 feet 6 inches long and designed for Howden draft. The boilers are placed in three batteries of three each, and are fired in the fore-and-aft direction, the coal being carried in two large bunkers athwartship, this arrangement making four distinct fire rooms. The bunkers are so placed that the coal is practically self-trimming onto the fire doors directly in front of the fires, practically eliminating coal passing. Bennett flue blowers are installed in all boilers.

There are four funnels, with outer casings fitted up to the level of the top deck and single above. The stack, forward, is fitted with one 10-inch by 36-inch whistle and one 6-inch organ whistle.

The ashes are discharged outboard by eight hydraulic double-jet ash ejectors of improved design. The stokeholds are roomy and well ventilated, and designed with safety escapes and with a view of comfort for the stokers.

Electrical Equipment

Altogether there are 4,500 electric lights aboard the ship. Practically every function that can be is performed by electricity. The generating sets consist of three turbine engines direct connected to dynamos, and along with the main switchboard are located in the engine room on the main deck. The boat is wired throughout with the new National Board of Underwriters' marine core wire, and the conduits for carrying the wire are of galvaduct. The main switchboard is equipped with automatic circuit breakers and also double-throw switches, so that all power can be put on any one dynamo should it be necessary. All fuses in the switchboard and distributing boards are of the 250-volt National code type. The circuits are so arranged that the electrician can disconnect any number and combinations of lights, still leaving light enough to get around. This is convenient, of course, for the night lighting of the ship when fewer lights are required.

The telephone system is in full equipment exactly similar to a system in vogue in cities, having motor generator for calling and a central storage battery for talking. There are over 500 telephones on the boat, one in every stateroom, as well as in the officers' quarters and in the telephone booths, with the main switchboard in social hall. In addition, of course, to this public telephone system, there is a private system for the operation of the ship leading from the pilot house to the engine room and other departments.

The steamer is, of course, equipped with wireless and also carries an auxiliary storage battery plant, which will operate for six hours if by any accident the boilers should be put out of commission. Alarm boxes are placed at convenient intervals, which are rung at stated times by the night patrol and register in the pilot house.

An automatic signal board placed in the pilot house controls the signal lights of the ship. These lamps are carried in duplicate, one dormant and the other burning, and if by any chance the burning light goes out the other is automatically thrown in and registers in the pilot house. Assurance is therefore given that the port and starboard and other signal lights are always burning, or at any rate that if anything is wrong with them it is immediately announced.

In addition to the usual engine telegraph the means of communicating intelligence from the pilot house to the engine room are many, including an electric signal bell system and also an electric indicator connected with the main shaft, which indicates whether the engines are going forward or astern. The system of electric fans throughout the boat is quite complete and is especially elaborate and painstaking in the dining room. All the drinking water is passed through copper tubes and purified by electricity before being served. Many of the functions of the galley are also performed by electricity. A 32-inch searchlight, the largest on the Lakes, is provided.

McAndrew's Floating School

BY CAPTAIN C. A. McALLISTER*

CHAPTER IX (Continued)

"The bed-plate is the part of the engine which supports the weight of the entire structure, and also forms the seating for the crankshaft or main bearings. They are usually made of cast iron and sometimes of cast steel, and consist of a series of athwartship girders, one under each crankshaft bearing, all being joined by fore-and-aft girders, one on each side. Naturally, they are made as heavy and substantial as possible. The

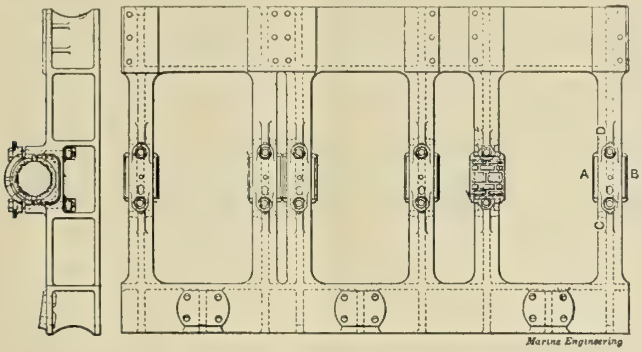


FIG. 10.—BEDPLATE FOR TRIPLE-EXPANSION ENGINE IN ONE CASTING

bed-plate is secured to the foundation, an integral part of the ship's structure, by means of holding-down bolts. Fig. 10 will show you an ordinary type of bed-plate and Fig. 11 a main bearing, or 'pillow block,' as it is sometimes called.

"The main bearing shown in this sketch is such as used for small engines. On larger engines the bottom brass and the cap or binder, as the top bearing is called, are usually cored to

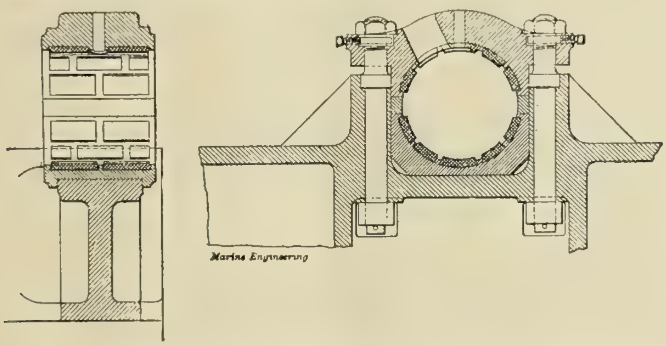


FIG. 11.—DETAILS OF BEDPLATE IN FIG. 10. SECTIONS SHOWING MAIN PILLOW BLOCK

allow for the circulation of sea water in order to prevent the bearing from becoming unduly heated when the engine is run at full speed. All main bearings are lined with Babbitt or other anti-friction metal to reduce the friction."

CHAPTER X

Valves and Valve Gear

"Having gone over the principal parts of the engine, we will now take up some of the minor parts, the principal one of which is the valve gear.

"It is highly important to allow the steam to enter the cylinder at the right time, and it is equally as important to let it out at the right time. These operations must necessarily be performed automatically. The story is told that in the first engine built by James Watt, which was, of course, a very crude affair, he had not progressed far enough in his design to have the valve operated by the engine itself, and, in consequence, a boy was employed to lift the valve and close it at about as near the proper time as his limited training and judgment would allow. Evidently tiring of such monotonous employment, and being of an ingenious turn of mind, he noticed that a certain part of the engine mechanism had about the same motion which he imparted to the valve and at about the same time. Consequently, as the story goes, he tied a stout piece of cord to the valve lever and connected it to the part of the engine which had the coincident motion, whereupon the valve was actuated automatically, and the boy was found by his employer out in the yard playing marbles, civilization having not advanced sufficiently far at that remote period to permit of the youngster indulging in the more scientific game of shooting craps.

"That boy unconsciously formed the first valve gear ever put on an engine, but since his time there has been considerable improvement in the method of actuating valves. Before

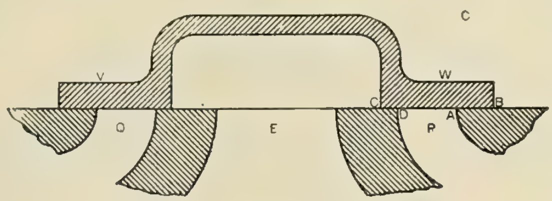


FIG. 12.—PLAIN SLIDE VALVE, MID-POSITION

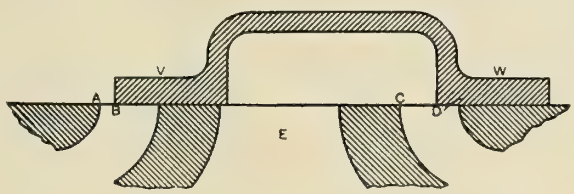


FIG. 13.—PLAIN SLIDE VALVE, POSITION FOR END OF STROKE

describing any methods for moving the valve, you had first better be given an idea of the valve itself. There are a number of different kinds of valves used on stationary engines, but for marine engines there is practically but one type used, and that is known as the slide valve.

"There are two principal types of slide valve: the flat D and the piston valve. The simplest kind of a flat D slide valve is like Fig. 12.

"This valve, by sliding back and forth over the valve seat, alternately admits and releases steam to and from the cylinder which drives the piston up and down. In Fig. 12 the valve is shown in what is known as its mid-position. The amount which the valve overlaps the steam port in this position, *A B*, is known as the 'lap' of the valve, and you must fix that in your memory, as it is frequently referred to by all marine engineers. There are two kinds of lap, as you will notice that on the inside of the valve it also extends over the port the distance *C D*. The outside lap, *A B*, is known as the 'steam lap,' and the inside lap, *C D*, is the 'exhaust lap.'

"In Fig. 13 the valve is shown at the end of its stroke, and you will notice that the valve has opened one of the steam ports on the outside a distance, *A B*; this is known as 'lead,' and there are two kinds of lead also; the outside, or

A B, being known as the 'steam lead,' and the inside, or *C D*, being known as the 'exhaust lead.' "

"Chief, that sounds like horse race dope, the kind I used to hear down at Brighton Beach," said O'Rourke. "I suppose you will be telling us next that the high-pressure valve is in the lead—one lap ahead of the low-pressure."

"No doubt, young man, you know more about horse race dope than you do of anything else; but this is no place for such silly remarks," tartly rejoined McAndrew.

"Why does a valve have this lap?" inquired Nelson.

"There is some sense to a question like that," said the instructor. "Lap is given to a valve so that the steam can be cut off at a portion of the stroke and be allowed to expand in the cylinder. If the valve was made the same over-all length as the distance between the outer edges of the two steam ports, live steam from the boiler would be allowed to follow the piston nearly the entire stroke, and we would gain nothing from the expansive effect of the steam.

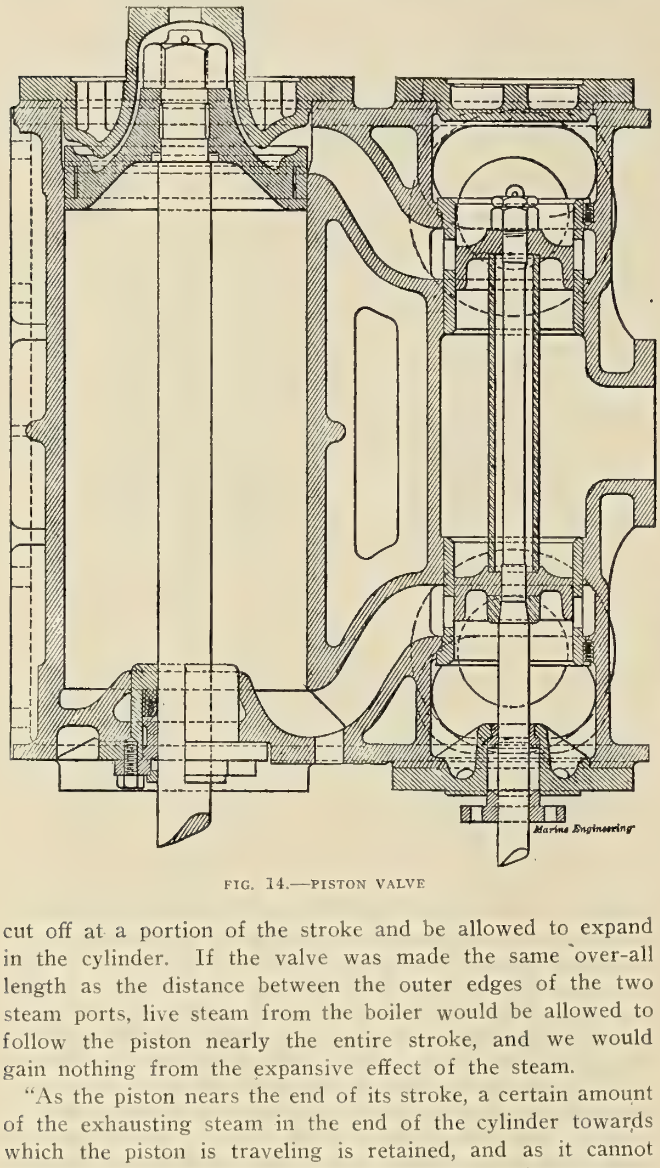


FIG. 14.—PISTON VALVE

"As the piston nears the end of its stroke, a certain amount of the exhausting steam in the end of the cylinder towards which the piston is traveling is retained, and as it cannot escape it is compressed and forms a cushion, which overcomes the momentum of the piston, rod, etc. As this is generally insufficient to overcome so much momentum, the live steam for the return stroke is admitted prior to the time when the piston starts on its return. The amount the steam valve is open at the very commencement of the return stroke is, as before stated, known as 'lead,' the purpose of which is to aid in quickly overcoming the momentum of the moving parts and to start the piston back quickly on its return.

"Some old-fashioned simple and compound engines are furnished with a cut-off valve separate, and working upon the back of the regular valve in order to get a sufficient amount of expansion of the steam, but in triple or quadruple-expansion engines we do not need to cut off closely in the high-pressure cylinder, as there are three or four cylinders in which the expansion may take place. A double-ported slide valve is one used when it is desired to get a very large port opening for a comparatively short valve travel; it is practically one valve within another, and there are two steam ports instead of one in the valve seat, the steam for the outside ports entering over the ends of the valve and the steam for the inner ports coming through passageways in the sides of the valve. On nearly all large cylinders it is found necessary to use these double-ported valves, or otherwise the valve travel would be entirely too great.

"The great disadvantage in using the flat slide valve is the large amount of power consumed in overcoming the friction between the valve and its seat. For instance, a slide valve of ordinary size would be, perhaps, 30 inches long by 42 inches wide, a flat surface of 1,260 square inches. At only 40 pounds pressure per square inch in the steam chest there would be a pressure of over 50,000 pounds pressing the valve against the valve seat. You can readily imagine that the friction caused by moving iron against iron with such a load as that is enormous. Therefore, flat slide valves are not used to any great extent nowadays except in small engines, and then only for the low-pressure cylinder, where the initial pressure of the steam entering the cylinder is usually not over 5 to 10 pounds.

"Some wise old-timer, to get away from using flat slide valves, conceived the idea of wrapping up his slide valve into the form of a cylinder, and thereby removing all unbalanced pressure from the valve while retaining the advantages of the slide valve. Its essential features are two pistons or heads joined by an intermediate distance piece, all being held in place on the valve stem by nuts and washers, as shown in Fig. 14.

"The steam is admitted and exhausted to and from the cylinder by the edges of the valve in precisely the same manner as the flat slide valve. The only disadvantage is the excessive clearance as compared with the flat valve."

"What's clearance, Chief?" remarked Nelson.

"The clearance space in an engine is the volume of the steam ports and passageways between the piston and the bottom and top heads of the cylinder. It would never do to have the moving piston strike the head, either at the bottom or top, for if it did it would knock them off. Consequently there is usually a space of about ¼ inch at the top and ⅜ inch at the bottom, always more at the bottom to allow for the bearings wearing down. These distances are known as the linear clearances, while the entire volume of the space between the piston at the end of its stroke and the cylinder head, plus the volume of the steam passageways, is known as the volumetric clearance. Naturally, as the ports have to reach clear around the piston valve, there is more of this volumetric clearance for this type than there is for a flat valve which lays close up to the cylinder. In modern engine designs this volume is considerably decreased by making the ports straight instead of curved, as shown in the sketch.

"Piston valves can be kept tighter than flat slide valves, for the reason that it is usual to fit the two pistons composing the valve with packing rings similar to those used for the main pistons."

"We have looked into the principal kinds of valves used on marine engines and know what functions they perform, now we want to know what kind of apparatus it is that moves the valves. There are three principal types of operating gear used on marine engines, known by the names of the inventors, respectively, as 'Stephenson,' 'Joy' and 'Marshall.'

"The Stephenson gear is probably used on over 90 percent of the marine engines in use. If ship's engines had to travel in one direction only, the valve mechanism would be comparatively simple, but engines of this kind, as well as those on locomotives, have to be reversed frequently, so it is necessary to have the valve gear designed so that it can go either ahead or back.

"This condition was quite readily solved by Stephenson, one of the first engineers, when he invented his link gear. In this mechanism the fundamental motion is taken from the

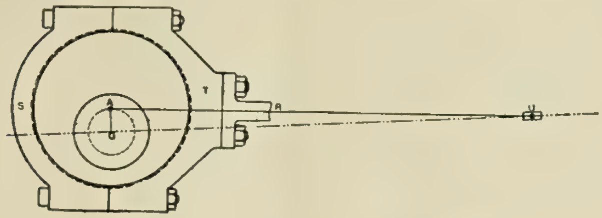


FIG. 15.—PLAIN ECCENTRIC, SKELETON MOTION

crankshaft by means of eccentrics keyed to the shaft. Perhaps O'Rourke can tell us the difference between an eccentric and a crank."

"That's easy," replied the ever-ready. "If a rich man does queer things he is an eccentric, but if a poor man does the same stunts everybody calls him a crank."

"Well, that brings out the idea, anyhow," continued McAndrew. "There is in reality very little theoretical difference between an engine eccentric and a crank, as an eccentric is practically a self-contained crank. The term 'eccentric' means literally 'having different centers,' whereas 'concentric' means having the same centers. Hence it is that the center of the sheave, forming the eccentric, is set off from the center of the shaft upon which it operates, a distance which is known as the 'eccentricity' or 'throw.' The following will illustrate the idea of the eccentric:

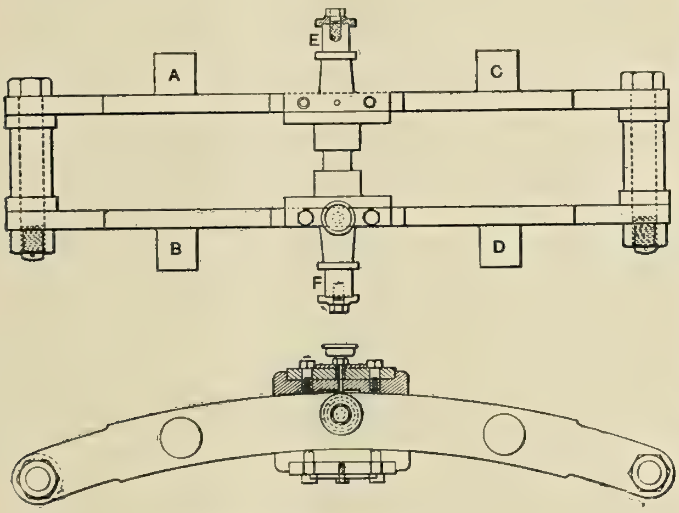


FIG. 16.—STEPHENSON DOUBLE BAR LINK

"The distance *A C*, Fig. 15, between the center of the shaft and that of the sheave is the throw, and the up-and-down motion imparted to the valve, or the valve travel, as it is known, is double this throw. Around the eccentric sheave is fitted a band or strap, as it is termed, made in halves and bolted together, which strap is bolted to the heel of the eccentric rod. This rod is forked at its upper end and spans one end of the link. There are two eccentrics and all the necessary connections for each cylinder, one known as the 'go-ahead' and the other as the 'backing' eccentric. The go-ahead eccentric rod connects with one end of the link and the backing eccentric rod with the other end.

"Almost all links for large engines are of the double-bar type; that is, they are built up of two parallel steel bars, each forming the arc of a circle, the radius of which is equal to the distance between the center of the eccentric sheave and the center line of the bars.

"You will notice the mechanism in the center of the link. That is known as the link block, and it forms the connection between the link and the valve stem. In operation the links are thrown from one side to the other, so that the link block is actuated by either the go-ahead eccentric or the backing eccentric, as may be desired, by placing the link block in line with either of these eccentric rods.

"Eccentric sheaves are always made of cast iron, in two unequal halves, in order to bring the joint between them on the center line of the shaft, so that they can be readily removed.

"The eccentric straps which ride on the sheaves are also made in halves, bolted together, and are usually of cast iron or cast steel, lined with white metal in order to reduce the friction.

"Eccentric rods and link bars are usually made of wrought steel of the best quality. The link blocks are usually of forged steel, fitted with composition wearing pieces where they rub on the link bars. Sometimes they are cast entirely of bronze.

"To reverse an engine, that is, to change it from the ahead motion to the backing motion, or *vice versa*, there is provided a rock shaft, which extends along the engine columns, and to

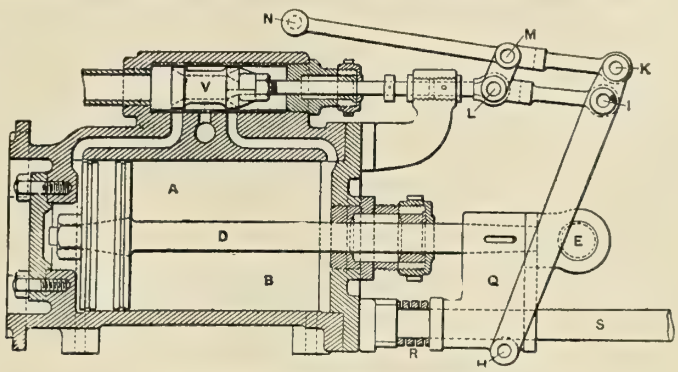


FIG. 17.—FLOATING LEVER REVERSE GEAR

which it is supported in brackets. On this rock shaft there is secured for the valve gear of each cylinder a lever, or reversing arm, as it is called. This arm connects to the valve gear links by suspension or bridle rods, as they are sometimes called. This rock shaft on small engines is operated by hand through the medium of a long lever, or in some cases by a large hand-wheel and screw. However, this means is not practicable for larger engines, as it would require more power than a man could apply. Hence all large marine engines are fitted with what is known as a reversing engine, which consists of a steam cylinder, the piston rod of which is connected by means of links to the reverse arm on the rock shaft. Fig. 17 will show you details of an ordinary reversing engine.

"The valve of this steam cylinder is controlled by what is termed a 'floating lever,' the initial motion being given it by means of the hand reversing lever located at the working platform. A small slide valve of either the flat slide or the piston slide type controls the admission of the steam to the cylinder. Unless the lever at the working platform is handled by an experienced man, the piston is liable to go forward or backward with a rush, causing the gear to slam. To avoid any damage being done it is customary to fit strong spiral springs at each end of the crosshead guide rod to prevent slamming."

(*To be continued.*)

NEW ENGINEER-IN-CHIEF OF THE UNITED STATES NAVY.—Rear Admiral Robert S. Griffin, U. S. N., has been appointed chief of the Bureau of Steam Engineering, succeeding Rear Admiral H. I. Cone.

Letters from Practical Marine Engineers

Incidents Relating to the Design, Care and Handling of Marine Engines, Boilers and Auxiliaries; Breakdowns at Sea and Repairs

Diagram of Formula for Vertical C. B.

Any reliable approximate formula is welcomed when checking completed calculations or when approximate results are wanted in the preliminary stages of a design. Graphical representation of a formula offers the additional advantages of being able to read the answer directly on a scale and of avoiding much arithmetical work. Also the effect upon the final result, due to a small change in any of the factors entering into a formula, is immediately *seen* in a diagram.

A case in point is Normand's approximate formula for vertical position of center of buoyancy. In its original form this formula gave the *C. B.* below *L. W. L.* in terms of draft,

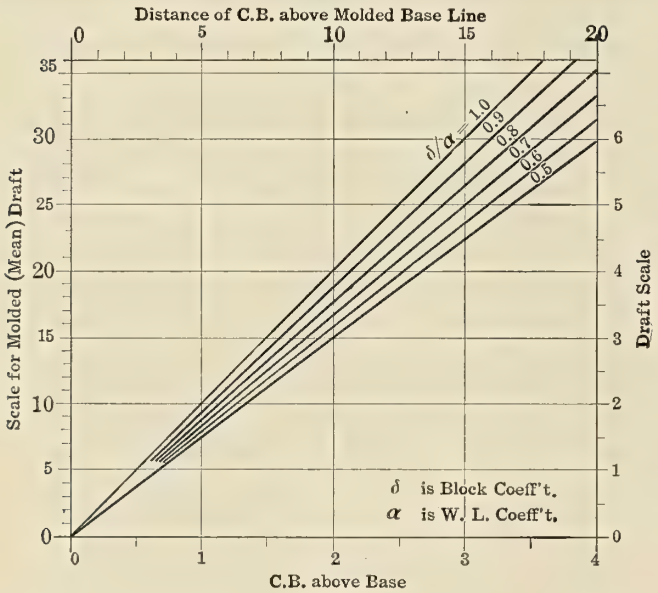


FIG. 1

displacement (volume) and area of water plane. In Simpson's "Naval Constructor," page 45, convenient substitutions have been made, the formula being transformed to read:

$$C.\ B.\ \text{above molded base line} = d\left(\frac{5\alpha - 2\delta}{6\alpha}\right) \text{ where } d =$$

mean draft, molded.

α = coefficient of water plane.

δ = block coefficient.

Fig. 1 is a graphical representation of the above formula. The left-hand vertical draft scale extending to 36 units is used in association with the top horizontal scale to 20 units of *C. B.* above base. Using only the large figures of each scale (*i. e.,* up to 3.6 units vertically and 2 units horizontally) a virtual enlargement is obtained of the extreme lower left hand corner of the diagram. A similar virtual enlargement is obtained by using the right hand vertical draft scale in conjunction with the bottom horizontal scale.

Each of the radial lines in the diagram corresponds to a particular value of δ divided by α. Intermediate values of this ratio can be located by interpolation in a *horizontal* direction, since the intervals on a horizontal line between successive radial lines are equal.

Example: Find the vertical position of *C. B.* for a vessel 8,730 tons displacement at 21 feet draft (above top of keel). The area of 21 feet water plane is 15,900 square feet, length 383 feet by 50 feet breadth.

$$\text{Then } \delta = \frac{8{,}730 \times 35}{383 \times 50 \times 21},$$

$$\text{and } \alpha = \frac{15{,}900}{383 \times 50}.$$

$$\text{Whence } \frac{\delta}{\alpha} = \frac{8{,}730 \times 35}{383 \times 50 \times 21} \times \frac{383 \times 50}{15{,}900} = \frac{5 \times 8{,}730}{3 \times 15{,}900} = 0.91 +$$

Opposite the 21-foot draft mark (left-hand vertical scale) locate the value of the δ/α ratio (= 0.91 +) between the radial lines 0.9 and 1; then project this point up to the top horizontal scale and read off the distance of *C. B.* above base = 11.1 — feet, which probably contains less than 1 percent error.

WILLIAM S. OWEN, B. SC.

Cramp's Shipyard, Philadelphia.

Calculations for Strength of Propeller Blades and Studs

The following methods of calculating the bending stress at the root of propeller blades and the tensile stress on the studs securing the blades to the hub have been demonstrated to be thoroughly reliable in practice, and will be of service to draftsmen or engineers engaged in designing propellers.

Let S = the bending stress in pounds per square inch on the root section of a propeller blade.

I = the total indicated thrust in pounds.

$$= \frac{33{,}000 \times \text{I. H. P.}}{\text{pitch of screw} \times \text{revs. per min.}}$$

a = the flat area of one blade.

p = the projected area of one blade.

n = the number of blades in *all screws.*

m = the distance in inches from the root section of the blade to the center of effort of the blade (see sketch).

b = the breadth of blade at the root section in inches (see sketch).

d = the thickness of blade at the root section in inches (see sketch).

$$\text{Then } S = \frac{I \times a \times 12\,m}{n \times p \times b \times d^2}.$$

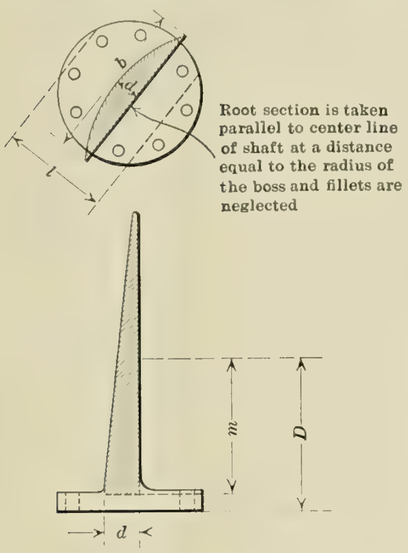
Comparing a number of cast iron blades by this formula showed that in actual practice S ranged from 1,600 to 2,700 pounds.

In calculating the stress on the studs, it is advisable to add to the tensile stress produced by the thrust on the blade the tensile stress produced by the centrifugal force of the blade. This latter force was not dealt with in considering the root section, because its effect on the root section is comparatively trivial, owing to the large area of the section, but the total net section of the studs is small compared to the root section and the stress produced by centrifugal force is quite appreciable.

All the symbols above apply to the following formula, and in addition:

Let T = the mean tensile stress in pounds per square inch on the studs.

D = the distance from the face of the hub to the center of effort of the blade in inches (see sketch).



SKETCH OF BLADE, SHOWING SYMBOLS FOR FORMULA

C = the tension area of all studs on aft side of one blade in square inches.

l = the average length in inches of the arm at which the studs on the aft side of the blade act to resist the overturning action of the thrust on the blade (see sketch).

W = the weight of one blade in pounds.

R = the radius of the center of gravity of the mass of blade in feet.

N = the number of revolutions of the propeller per minute.

Y = the tension area of all studs in one blade in square inches.

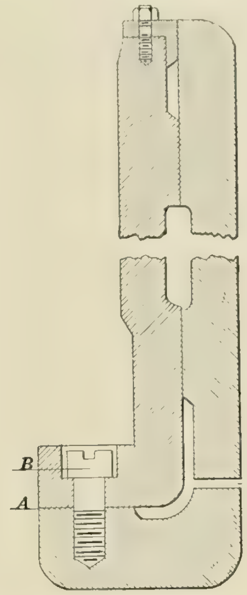
$$\text{Then } T = \frac{I \times a \times D}{n \times p \times c \times l} + \frac{W \times R \times N^2 \times .0003427}{Y}.$$

From a number of actual propellers it was found that T, the mean stress on the studs, was about 2,000 pounds per square inch and the maximum stress on any one stud was about one-third greater than the mean stress.

Toronto, Can. R. M. FOTHERINGHAM.

A Leaky Joint on a Cylinder Liner Made Tight

Our low-pressure liner leaked so badly at the bottom where the flange made up on the cylinder at A that the hand on the jacket gage oscillated from the pin to the full pressure allowed on the jacket at every stroke of the piston. The lower manhole plate on the cylinder had been removed, and the bolts, B, holding the flange inside the cylinder had been set up as tight as possible, but in spite of all that we could do we could not make the joint tight. This continued to be very trying for several weeks, for every time that we arrived in port some one was obliged to remain aboard and try to make the liner tight, and each time something else was tried. At last the lagging was removed at the bottom of the cylinder and a hole drilled and tapped to take a ¼-inch pipe 3 inches above joint at C. The cylinder was warmed to about 200 degrees, so that thinly mixed red lead would run nicely, and enough was forced through the hole between the liner and the cylinder so as to be about 1 inch deep at the bottom, then air pressure was applied until the lead was forced through the joint when the pressure was reduced to 5 pounds and allowed to stand for ten hours until the lead became quite thick, then the pressure was increased to 40 and allowed to stand until the lead became hard, the cylinder being kept fairly warm by



METHOD OF TIGHTENING JOINT BETWEEN CYLINDER AND LINER

letting just enough steam through the bypass valve to keep it at the required temperature. Then the pressure was removed, the lead cleaned off that had been forced through the joint on the inside, the hole plugged, the lagging replaced, and the liner has been perfectly tight ever since. READER.

Counterbore and Packing Ring

The steamship R——— was loading at New York for a voyage of 4,000 miles to the southward. Included in the overhauling was the fitting of a new ring in the high-pressure cylinder.

This cylinder was 33 inches in diameter, of 54-inch stroke and fitted with a liner. The piston was of the ordinary marine type, being made tight by a single snap ring 1¼-inch square fitted in a groove in the center of the bull ring. In boring the liner a mistake had evidently been made, for the counterbore extended 1½ inches above the flange of the piston when the engine was on the bottom center.

In trying the ring it was placed on the flange of the piston and the first assistant engineer ordered the engines jacked around while he watched the ring to see if it was clear in the cylinder. As it neared the bottom of the stroke he saw it spring out on one side, and immediately ordered the jacking engine stopped.

The oiler who was running the jacking engine, misunderstanding the order, reversed the engine. One sharp report and one-third of the piston flange dropped off. As it was less than twenty-four hours to sailing time, and as a spare piston was not on hand, it was necessary to repair the broken one, which was accomplished as follows:

The follower was clamped on the bull ring in its relative position on the platen of a drill press, and between the follower bolt holes, there being 12, was drilled a ⅞-inch tapping hole into the bull ring. These holes were tapped ⅞ inch and Norway iron studs made to screw into the same long enough to pass through the follower and allow for heading up. The holes in the follower were then reamed to pass over the studs and given a good countersink. The follower was again clamped on the bull ring and the studs riveted up tight, making the bull ring and follower one.

Meantime the bottom die on the cylinder had been removed, all broken pieces taken out of the cylinder and the die replaced. The snap ring was placed in its groove and the piston bolted together. As the follower was a good fit in the cylinder the stress on the studs was practically nothing.

The ship sailed on time and made the voyage of 4,000 miles without the cylinder giving trouble. On returning to New York a new piston having a solid floating bull ring was fitted which could not get into the counterbore.

ENGINEER.

An Improvised Device

The trap of our evaporator had its side and bottom corroded so badly that it was beyond repair, and not being able to get another one at the time, the drain was connected from the coil to the feed tank direct, and was regulated with a valve; but this was, of course, all guesswork; and the evaporator being situated in the shaft alley, it took a special trip to have a look at it, and the coil was either empty and blowing live steam into the feed tanks or filled with condensed water and not evaporating anything, where with a good trap one could get so used to regulating it that it was very little trouble. This was necessary, as the oiler had to attend to running the evaporator as well as attending to his other duties, but under the above condition it had become more troublesome than the main engine. One of the oilers devised a scheme that worked so well that we never replaced the trap.

A piece of 4-inch pipe with a cap on the bottom and a flange and stuffing box on top, that had once belonged to a pump governor, was made up and the stuffing box was made to fit a

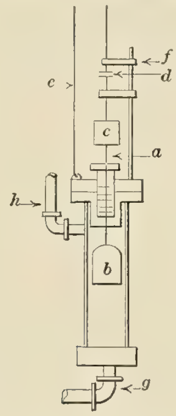


DIAGRAM OF DEVICE

⅝-inch rod, *a*, with a float on the lower end, *b*, and extended up through a guide that was screwed into the top head and carried a small weight, *c*, just heavy enough to force the rod down when the water in the 4-inch pipe was low enough not to come in contact with the float, but when the water in the evaporator coil raised higher than it should the float would raise the rod and make a contact at *d*, and this wire, with wire, *e*, was run over to the throttle and connected up to the ship's wiring and a buzzer so that the man at the throttle would know when the coil needed blowing, and he could tell by the sound of the steam going into the feed tank when it needed closing. A drain valve was installed near the throttle, so it was very little trouble for him. The wire at the place of contact was insulated at *f*. Pipe *g* had a connection with the coil drain and pipe *h* to the steampipe on the evaporator side of the reducing valve, so that the same pressure was maintained on the coil and the electric apparatus. The pipes *g* and *h* were insulated by enlarging the bolt holes in a flange on each and inserting the bolts in a fiber tube turned to fit the bolts and bolt holes and a fiber washer under the head and nut. This was done to prevent electrolysis on the shell and fittings of the evaporator. Of course this was not automatic, as a trap would have been, but it worked very nicely, and after a short time the man at the throttle became so proficient in regulating the drain that it was not necessary to touch it more than three or four times a watch, and it was always in repair, which can't always be said of traps.

OILER.

Propeller Shafts—How to Preserve and How to Protect Them

Engineers have tried various methods of preventing corrosion to the propeller shafts of steamers, as well as of reducing the friction in the stern tubes. Water, as is well known, is not a lubricant, and yet, strange to say, 70 percent of the steamers running depend on water for the lubrication of their stern bushes and propeller shafts. No engineer would lubricate his engine with sea water, and yet the most important bearing in the ship is usually lubricated with it.

If a suitable lubricant can be employed in the stern tube, it stands to reason that the friction would be greatly reduced. Careful experiments conducted by a prominent marine engine builder have clearly proved this. It has been ascertained that with a shaft having a brass liner running in a lignum vitæ bush and lubricated with sea water, the coefficient of friction is 0.094, whereas with a steel shaft running in white metal and lubricated with oil the coefficient friction is 0.048.

Some engineers have tried tallow or solidified oil in the stern tubes, but these are not desirable for several reasons. Tallow somtimes contains mineral acids and usually also an appreciable percentage of free fatty acid; it has also a tendency to turn rancid and to generate still more fatty acid. These acids tend to corrode the shaft and to perpetuate the galvanic corrosion which is caused by sea water. Another objection to tallow and to all solid lubricants is that any particles of sand which enter the stern bush are kept up against the shaft and act like a file upon it.

Any oil used in a stern tube should be non-corrosive, not only free from mineral acid but free from fatty acid; it should also be a semi-solid or non-fluid oil, for a thin oil has a much greater tendency to work out of the stern tube and be lost. The difficulty is to find a non-corrosive oil which is really a good lubricant and yet free from fatty acid. Hydrocarbon oils, such as vaseline, are free from fatty acid, but they have not the "oiliness" or high lubricating power which is essential for a large bearing like the stern bush. The corrosion which takes place in the stern tube is usually the result of galvanic action, just the same as the corrosion between the two metals in the battery of an electric cell.

In selecting a lubricant for this purpose it is advisable to choose a non-corrosive lubricant with the peculiar power of adherence to metal surfaces, so that once on the tail shaft it would be practically impossible for water to wash it off; also one that has a very strong lathering power—that is, it should make when mixed with water a flat or velvety lather (not a frothy one) of a very rich nature. The shafts which have been lubricated with this class of oil for many years are not showing the least sign of corrosion or rust.

There are various methods of applying the oil to the tail shafts. Some engineers force it into the stern tubes and allow it to find its way out through the bush. Others simply feed the oil by gravitation, but sometimes both of these methods answer, although usually sooner or later they are found to work unsatisfactorily, for both of these methods are far from economical.

In a future article the author will deal with oil retaining and stern tube appliances. "GO-AHEAD."

Marine Articles in the Engineering Press

A French Diesel Engine.—In this article the design, construction and operation of the Sulzer-Diesel marine engine, as built in France at the works of the Forges et Chantiers de la Mediterranée at Havre, are discussed. While the Sulzer-Diesel engine is well known, there are some features in connection with the French development which differ from the designs produced by the parent works in Switzerland. The article is amply illustrated with drawings, diagrams and photographs. 7 illustrations. 4,000 words.—*The Engineer,* May 2.

The German Battleships of the Kaiser Class.—The German battleship *Kaiser* has the following main particulars: The length is 564 feet; breadth, 95 feet 3 inches; normal displacement, 24,119 tons; speed, 21 knots; main armament, ten 12-inch guns; secondary armament, twelve 5.9-inch and twelve 3.4-inch guns and five torpedo tubes. Sixteen watertube boilers of the Schulz type supply steam to impulse turbines of the A. E. G. type, distributed among three shafts and designed to develop 25,000 horsepower. The normal coal supply is 1,000 tons, the total coal and oil bunker capacity being 3,600 tons. The main armor belt is 12¾ inches thick, reduced to 6 inches and 5 inches at the ends; the turret armor is 12 inches thick. 1 illustration. 1,000 words.—*The Engineer,* April 18.

Motor Ship Suecia.—By J. Rendell Wilson. Burmeister & Wain, Copenhagen, recently built for the Redericktiebolaget Nordsjernan the motor ship *Suecia,* 362 feet long overall, 360 feet long between perpendiculars, 51 feet 3 inches beam, 25 feet 6 inches molded depth, 23 feet 1 inch draft, 6,520 tons deadweight capacity, 2,300 indicated horsepower, 10¾ knots speed. She is a twin-screw vessel with eight-cylinder engines, having cylinders 16½ inches diameter by 19.8 inches stroke, operating at 140 revolutions per minute on the four-stroke principle. The auxiliary machinery includes two 200 brake-horsepower four-cylinder non-reversible Diesel four-stroke engines, driving dynamos and air compressors. 2 illustrations. 750 words.—*Marine Review,* May.

Geared Turbine Steamers for the South Indian Railway.—Three geared turbine steamers, the *Curzon, Hardinge* and *Elgin,* have been built by A. & J. Inglis, Ltd., of Pointhouse, Glasgow, for the South Indian Railway Company. The vessels are 260 feet long overall, 38 feet beam, 18 feet 9 inches depth to promenade deck, with a gross tonnage of about 700. The propelling machinery consists of two sets of geared Parsons turbines driving twin screws. To each shaft a high-pressure and a low-pressure turbine are coupled by means of machine-cut gearing, which enables the turbines to be run at 3,500 revolutions per minute, while insuring an efficient low speed for the propellers. A high-powered astern turbine is embodied in each low-pressure casing. Two Yarrow watertube boilers, specially designed for burning inferior qualities of coal, supply steam. The vessels are provided with bow and stern rudders, controlled by steam-steering gear. 6 illustrations. 350 words.—*The Engineer,* May 2.

Destroyer Developments.—The name torpedo boat destroyer no longer describes the functions of the vessels designated under this class; for their efficiency as war units must be judged not in relation to torpedo boats, but by their value for delivering torpedo attacks on battleships and battle cruisers under war conditions and on the high seas. It is held inevitable, considering the advance in speed of the larger units and the increasing effectiveness of the submarine, that what has hitherto been called the destroyer class should move to a somewhat more important position. It is suggested that if the destroyers were increased to a length of from 300 feet to 320 feet, with a speed of 36 knots, they would be effective both as torpedo vessels and as dispatch cruisers or scouts, thus creating a class of torpedo scouts which would become a real menace to hostile battleships or cruisers. Recent developments of propelling machinery, so that the necessary power for such vessels can be produced on comparatively small weight, makes the creation of such a class of war vessels seem desirable. 1,350 words.—*The Engineer,* March 14.

The Shelter Deck Cargo Steamers Bridgeport and Glacebay.—The steamers *Bridgeport* and *Glacebay,* built by Messrs. William Doxford & Sons, Ltd., of Sunderland, for London owners, constitutes a type of ship particularly suitable for the carriage of heavy bulk cargoes, such as coal and ore. A leading feature is that wing ballast tanks have been provided on each side for nearly the full length of the shelter 'tween decks. The vessels are 458 feet long overall, 442 feet 9 inches long between perpendiculars, 58 feet extreme breadth, 28 feet 9 inches molded depth to upper deck, 35 feet 9 inches molded depth to shelter deck, 25 feet load draft, 11,000 tons load deadweight, 710 tons bunker capacity. The five cargo holds in the vessels are each provided with a hatchway 35 feet wide by more than 40 feet long. Deep frames of channel section, spaced 37 inches apart for the greater part of the length, support the side plating. The propelling machinery in each vessel consists of one set of triple-expansion engines, having cylinders 28½, 47 and 78 inches diameter by 54 inches stroke, driving a single screw. The boilers are of the ordinary cylindrical multi-tubular type. 2 illustrations. 600 words.—*The Shipbuilder,* May.

Some Further Notes on Approximate Stability.—By Arthur R. Liddell. The method of constructing a curve of levers for the longitudinal stability of a ship is given, and this subject leads to the discussion of the safety of a vessel against foundering. It is pointed out that the safety would be greater than it usually is if vessels were made broader and deeper on given lengths and drafts than at present. The reasons why they are not so designed are: (1) That their tonnage would be greater and their dues heavier; (2) that thickness is now apportioned by the size of the vessel and not enough by the stresses which they have to withstand. The dues might very well be assessed upon some other basis that would not hamper design. If the tonnage system cannot be given up, deductions might be allowed: (a) For excess of surplus buoyancy over the standard; (b) for excess of length of the fore and after peaks over the amounts of 5 percent of the length forward and perhaps a little less aft now ruling, since both these surpluses make for increased safety. The greatest longitudinal stresses in a vessel occur about mid-length, and to relieve this part as much as possible the centers of gravity of the fore and after bodies respectively must be above or nearly above their centers of buoyancy. The part of the total stress due to weight distribution is thereby minimized. The part due to wave action, which is greatest in degree in the smallest and least in degree in the largest vessels, cannot be avoided. The third source of longitudinal stress—that due to water pressure—must be kept down as much as possible by suitable design of the framing. 2 illustrations. 2,600 words.—*The Engineer,* April 25.

Weight and Freight of Merchant Ships.—An editorial discussion of the paper read before the Liverpool Engineering Society by T. C. Tobin, M. A., dealing with the question of how does the margin of freight-carrying displacement vary per ton of structural material for vessels of differing dimensions? The standard vessel adopted for comparisons in this paper is Class 100 A-1 at Lloyds, and is of the shelter-deck type. Calculations of weight were made for ships of the following dimensions: 300 feet by 40 feet by 24 feet to shelter deck, two decks; 400 feet by 50 feet by 32 feet to shelter deck, three decks; 500 feet by 60 feet by 40 feet to shelter deck, four decks; 600 feet by 70 feet by 48 feet to shelter deck, four decks. These calculations were made for two degrees of fullness, .80 and .65 block coefficient as representing normally the full-lined tramp and the intermediate liner type of vessel. In addition to these calculations others were made of a deep type ship by adding 8 feet to the depth, and also for a wide type by adding widths to the standard beam adopted, varying proportionately from 10 feet on the 600-foot ship to 5 feet on the 300-foot ship. The most striking conclusion from the author's figures is the marked advantage which the large ship possesses over the small one. Vessels above 400 feet long carry equal deadweight per ton of structural weights, although the speeds at which they are assumed to carry it are proportioned to the square roots of their lengths. In other words, as is generally known, the big ship is the economical one. The wide type seems to be only slightly more economical in the bigger ships, but there is a distinct gain by transition to the deep type, so that the most economical freight carrier is the large, full, deep, narrow type. 1,200 words.—*The Engineer,* March 7.

Spanish Transatlantic Liner Infanta Isabel de Borbon.—The steamship *Infanta Isabel de Borbon* is a sister ship of the *Reina Victoria Eugenia,* recently described in the engineering press, differing from the latter, however, in having three instead of four propellers. Two reciprocating engines drive the wing screws and an exhaust turbine the center shaft, whereas in the ship previously described, which had four screws, the inner shafts were driven by reciprocating engines and the outer shafts by exhaust turbines. The *Infanta Isabel de Borbon* was built by Messrs. Denny of Dumbarton for the Spanish Trasatlantica Company, a company which was formed fifty-seven years ago, and has been an important factor in the commercial progress of Spain. The history of the development of this company, and the type of vessels which have been in its service, are described in an interesting manner in this article. This company, of course, benefits by the act which was passed by the Spanish Government in 1909, known as the "Protection of the Mercantile Navy Act." Under this act the Compañía Trasatlantica was awarded the contract for mail service to practically all the important ports in the world associated with Spanish history and trade. In addition, the act provides for subsidies for shipbuilders graded not only according to the size of the ship but also according to the horsepower and speed. The principal dimensions of the *Infanta Isabel de Borbon* are: Length between perpendiculars, 480 feet; breadth, molded, 61 feet; depth, molded, 35 feet 9 inches. She is of the shade-deck type, with six steel decks, the hull being divided into watertight compartments by nine transverse bulkheads. Accommodations are provided for 250 de luxe, 100 first class, 80 second class and for 1,600 emigrants, while a crew of some 250 are also carried. This article describes the passenger accommodations and certain of the auxiliary machinery installations, such as the ventilating, refrigerating, electric and cargo-handling equipment. 8 illustrations. 4,300 words.—*Engineering,* May 2.

The Story of the Cunard Line.—Tracing the development of the famous Cunard Line from its inception in 1840 to its present premier position unfolds a fascinating tale of energy and vitality. The history of the line is, of course, well set forth by comparison of the various vessels which have been built for its service year after year. Starting with the pioneer steamship *Britannia,* which was a wooden paddle-wheel boat, 207 feet by 34 feet 4 inches, of 1,154 tons, built in 1840, a description is given of the various Cunard steamships up to the latest monster *Aquitania,* which is now being built. Aside from the details of the company's vessels, the article shows how the Cunard Line has recently become affiliated with other important steamship lines, such as the Anchor and the Thompson Lines. In conclusion, two points are emphasized in regard to the Cunard Line; first, the wonderful measure of safety with which its services have been conducted, for it still may be truly said that there has never been the loss of a Cunard mail steamer by which the life of a passenger has been sacrificed. The other point is its intense vitality. 15 illustrations, 2,800 words.—*Marine Engineer and Naval Architect,* May.

Progress in Motor Shipping.—An impartial view of the present state of development in the construction of large motor ships and the prospects for the future cannot be taken without weighing carefully many factors which enter into the question. The factor of most importance is the supply of fuel oil and its price. In purchasing fuel for ships, whether it is coal or oil, it should be remembered that a ship's supply of fuel cannot all be purchased at one point, but that the ship must buy her fuel at various ports where the price varies; so in order to strike a true comparison between the cost of operating a motor ship and a steamship the price of coal at various ports must be taken into consideration. Allowing the usual four-to-one ratio in comparing motor and steamships, it will be found that oil only ceases to be less economical than coal when it reaches the price of about $24 (£5) per ton, which is, the company's vessels, the article shows how the Cunard however, much higher than it stands at present. 1,800 words.—*The Motor Ship and Motor Boat,* April 24.

A Theory of Surface Condensation.—By D. B. Morison. The Contraflo kinetic condenser was evolved after patient and prolonged research, resulting in the ultimate adoption of the multiple-wedge chambers arranged in parallel within a shell, the flow through the wedges being continuous and the proportions of the wedges such as to reduce steam turbulence at entry, facilitate gradual air collection during flow, and promote air concentration at exit. The crucial problem in the attainment of high vacuum is how best to treat the small quantity of air which normally enters the condenser with the steam, and make at the same time provision for dealing with the much larger quantities which result from accidental and inevitable leakage into the system. The weight of air which always remains in a condenser must be reduced to a minimum, and must offer the least possible resistance to the transmission of heat to the circulating water. Furthermore, each air particle should take its shortest route from the exhaust inlet to the air outlet, and not linger on the way. Such a theory at once suggests that exhaust steam should enter a condenser as a uniformly moving column, the sectional area of the column being the plan area of the top row of tubes. The nearest practical approach to this requirement is a wedge section having a very narrow outlet. By means of the wedge the air is disposed in pressure gradations which reach a maximum at the outlet from the condensing chamber. It is, moreover, highly essential that the disposition of the gradations at the outlet shall be such that a given weight of air presents as small a surface area and as great a depth as the practical requirements of sufficiency of passage permit. Concurrently, the air pump is enabled to maintain such an air condition within the condenser that the air pressure at the air outlet is minimized, the air insulation within the condenser is reduced, and the greatest amount of heat is transmitted to the condensing water. Another phenomenon which must be utilized for promoting a higher efficiency of air pump is the kinetic energy of the inflowing steam. To do so it is necessary to deflect the current towards the air outlet, with the result that there is less air insulation in the condenser. 8 illustrations. 3,250 words.—*Journal of the American Society of Naval Engineers,* February.

New Books for the Marine Engineer's Library

Propellers

REVIEWED BY PROFESSOR W. F. DURAND*

Propellers. By Professor C. H. Peabody. Size, 5¾ by 9 inches. Pages, 132. Illustrations, 29. New York, 1912: John Wiley & Sons. Price, $1.25 net.

This book is intended as a practical abstract of the author's more extended treatment of the same general subject in his work *Naval Architecture,* and to which reference is made for the details of experimental work cited and for theoretical discussion. The purpose of the present volume is to present in a reliable and convenient manner a method of designing propellers based on model experiments and free from the intricacies of refined theoretical discussion.

All practical methods for ship or propeller design are based ultimately on the law of comparison or of kinematic similitude, and while the theoretical discussion of this law in detail presents many points of abstruse theory, the general conclusions and resulting methods may be stated briefly and readily applied.

The author has developed in detail a method for the design of the form of propellers based on the ellipse as the standard form of projected contour, and adapting the experimental results derived in the United States Experimental Model Basin in Washington to propellers of this form of projected contour, but with varying structural proportions, has derived a series of coefficients covering propellers of two, three and four blades, a range of values of the pitch ratio from .60 to 2.00, a range of values of the slip ratio from .06 to .34, and certain values of area ratio and of blade thickness ratio covering the range of usual practice in these respects.

By the aid of these coefficients introduced into the fundamental equations, the characteristics of a propeller to meet within limits any proposed schedule of operation may readily be determined. Several illustrative examples are worked through, and in addition to the propeller tables there are added tables giving various quantities likely to be of use in estimating power and speed.

The book should be of special interest to marine designers and engineers primarily concerned with the consideration of numerical and practical problems.

Miscellaneous

The Stoker's Guide to Promotion. Size, 5 by 7¼ inches. Pages, 179. Numerous illustrations. London, 1913: The Fleet, Ltd., 11 Henrietta street, Covent Garden, W. C. Price, 3s. 6d. net.

This book is useful particularly to firemen in the British navy, as it was intended to deal exclusively with the various examinations the naval stoker has to pass for higher rating. Although designed primarily to meet the needs of a certain class of men the book contains information which would be found very useful to a young man trying to work his way up from the stokehold to the position of an engineer in the mercantile marine. The first two chapters contain a concise and straightforward explanation and guide to arithmetic and mensuration. The next chapter takes up boiler questions, and as it is rather brief, considering the subject treated, it is evidently assumed that the stoker is very familiar with the boiler side of the question. The next chapter, and by far the most important in the book, is entitled "Engine Questions," and by giving almost every conceivable question that would be asked in an examination, together with the answers, illustrated in many cases by sketches, the student can gain a very comprehensive knowledge of the various details in a steamship engine room. It is pointed out in the foreword that any one having a good knowledge of the contents of the book is almost certain to pass examinations for promotion from the stokehold.

Johnson's First Aid Manual. Fifth edition. Edited by Fred. B. Kilmer. Size, 5¾ by 8¼ inches. Pages, 143. Numerous illustrations. New Brunswick, N. J. 1912: Johnson & Johnson. Price, 50 cents.

Accidents are by no means infrequent even in the best regulated shipyards, and it is of great advantage to have at least one man in the yard, if not more, who has some knowledge of how to give prompt aid to the injured. The book in review is a first-aid manual for everyday use, and almost everyone who can read or understand a picture can gain information from it which will be of great service in caring for injured persons in an emergency. The book would be a handy thing to have around a shipyard and serious trouble might be avoided if some of the men in the shop were familiar with its contents.

Engineering Writing

Handbook of English for Engineers. By Professor Wilbur Owen Sypherd. Size, 4½ inches by 6¾ inches. Pages, 314. Chicago and New York, 1913: Scott, Foresman & Company. Price, $1.50.

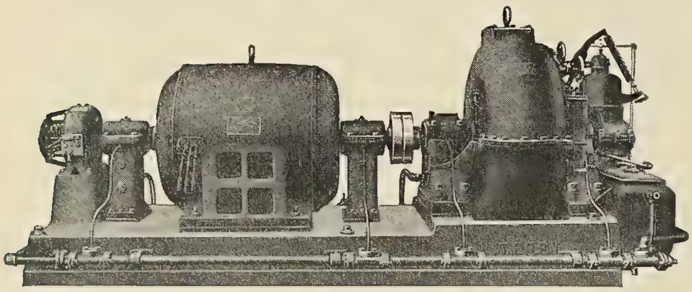
This book is designed primarily, as stated in the preface, to meet the needs of advanced engineering students and of young engineers in actual practice. In the preparation of the book the author has also kept in mind its usefulness to engineers already actively engaged in the practice of their profession. The scope of the book can be seen from the chapter headings, which are: Chapter I., The General Problems of Engineering Writing; Chapter II., Mechanical Details Common to the Various Forms of Engineering Writing; Chapter III., Business Letters; Chapter IV., Reports, and Chapter V., Articles for Technical Journals. The nature of the material in the book is such that the specimens of different forms of writing will not only serve as useful models for the inexperienced man, but they are also suggestive in a general way and will lead the reader to a true appreciation of the underlying principles established by custom and expediency which should govern all good engineering writing. The models of letters, reports and articles for technical journals illustrate the forms generally approved for such compositions, and should furnish useful suggestions for most of the writing required from engineers. The mechanical details common to the various forms of technical writing involve certain rules regarding punctuation, abbreviations, numbers, capitals, etc., which should be familiar to engineers in order to avoid confusion in important written documents. While the ability to speak and write English correctly and convincingly on almost any subject depends largely upon clear thinking and a thorough knowledge of the subject under discussion, yet the failure to master the ordinary technique of engineering writing imposes a serious and needless handicap upon an engineer, even if he is a man of exceptional technical ability. For overcoming such a handicap the book under review will be found in many ways a valuable aid.

* Professor of Mechanical Engineering, Leland Stanford University, Cal.

ENGINEERING SPECIALTIES

The Latest Type of Terry Turbo-Alternator

The Terry Steam Turbine Company, Hartford, Conn., who build turbo-generator sets from 5 to 300 kilowatts, either direct or alternating current, have recently put on the market the Terry "Type C H S," 3,600 revolutions per minute, turbo-alternator. In this set the bearings are supported from the base and close together; thus there is no expansion and change in alinement. The construction is costly all the way



through, but such as the builders consider proper where high speed is used. The casing is hung from the center and is split horizontally, as is the case with all Terry turbines. This means that alinement, steam connections, bearings, etc., are not disturbed to open the casing, which can, consequently, safely be done by the user if necessary. The equipment includes an emergency governor and steam strainer. A rugged self-contained forced feed lubrication system is used.

Miniature Voltmeters and Ammeters

There are many occasions when voltmeters or ammeters are required which are light, of small size, and yet accurate, durable and reliable. These conditions were met in the production of a line of miniature voltmeters and ammeters recently put on the market by the Weston Electrical Instrument Company, of Newark, N. J.

The instruments are constructed on the permanent magnet movable coil principle, and the line includes voltmeters, am-

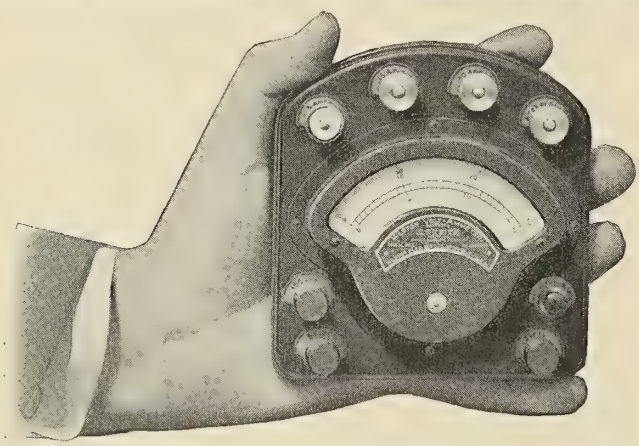


FIG. 1.—PORTABLE VOLT AMMETER

meters, volt-ammeters, special battery testing voltmeters and milli-ammeters. Single, double and triple range volt-ammeters are also offered in various combinations. The standard finish is dull black with nickel trimmings. The weight of these instruments is less than 1 pound each, and they are so compact that they may be easily carried in a coat pocket. The portable forms have knife-edge pointers, and the switchboard type has a pear-shaped or "spear-head" pointer, to permit its being read at a distance. The scale is 2.75 inches in length, and the entire instrument in portable form has outside dimensions of only 4.4 by 4.6 inches. These instruments are practically unaffected by changes in temperature, and are shielded against magnetic fields.

Fig. 1 shows a triple range volt-ammeter, which is just one-half actual size. With this instrument any current from 30 amperes to 0.05 ampere may be determined, and any voltage from 150 volts to 0.02 volt may be directly measured. Fig. 2 is a miniature switchboard meter. The movements in these instruments are practically identical with those in the port-

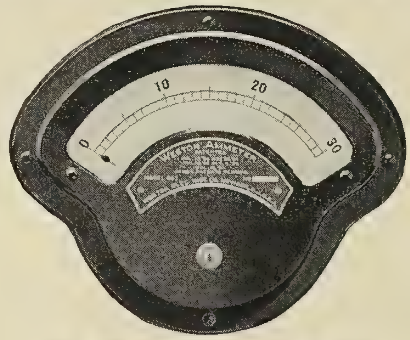


FIG. 2.—SWITCHBOARD VOLT AMMETER

able form. They are made only in single range with back connections.

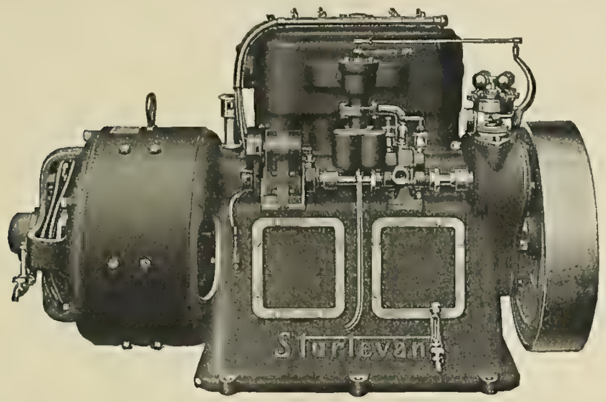
The company also manufactures a portable battery testing voltmeter, in which a steel point may be fastened to one terminal and a flexible cord with another point attached to the other terminal. These are furnished with the instrument and permit the rapid measurement of the individual cells of a battery. The scale is regularly calibrated with zero in center. On gasoline (petrol) launch switchboards and elsewhere, when space is an important consideration, and one instrument must be used for the determination of current and electromotive force, the company furnishes a special volt-ammeter. Normally, it indicates the charging or discharging current, but when pressure is applied to a contact button it registers volts without breaking the current circuit.

Sturtevant Gasolene (Petrol) Electric Generating Sets

The Sturtevant gasoline (petrol) generating sets, consisting of Sturtevant gasoline (petrol) engines, direct connected to Sturtevant direct-current electric generators, are built by the Sturtevant Manufacturing Company, Hyde Park, Mass., to supply the demand for electric generating sets that will be easy and inexpensive to operate. Gasoline (petrol) is a fuel that can be obtained anywhere, and gasoline (petrol) engines have been perfected so that they are reliable and require little attention, while they are cheaper to operate and more efficient than the steam engine. Furthermore, such a generating set can be easily operated by any one capable of taking care of an automobile or motor boat engine, and the services of an experienced engineer or of a person in constant attendance are not required.

Generating sets of this type are particularly useful for marine work, as they can be located on an upper deck in the ship, where they are unaffected by any accident in the engine or boiler room. The sets are built in three sizes of 5, 10 and 15 kilowatts capacity, capable of lighting 200, 400 or 600 20-candlepower tungsten lamps, respectively. A long-stroke engine has been designed as the most efficient and practical for this service, and both engine and generator are capable of operating under an overload of 25 percent for two hours. The engine is of the four-cycle water-cooled vertical type, with either four or six cylinders, according to the size of the unit. The generator is of the same type as has been used successfully in connection with Sturtevant steam engines for the United States navy and for the merchant marine.

The engines are fitted with an improved system of forced lubrication, while all moving parts are enclosed within an air-tight base, so that the sets are very clean in operation, are economical of lubricating oil and are easily taken care of. The speed of the engine is controlled by a specially designed vertical throttling governor of the centrifugal type, operated through bevel gears from the end of the cam shaft. It is claimed that the governor will control the speed of the engine to so close a degree of regulation between no load and



full load that voltage variations due to constant changes in load are imperceptible. The regulation is so close that no storage battery is necessary to maintain a constant voltage, when the generator is supplying current directly to the lighting or power circuit. Ignition is furnished by a high-tension Bosch magneto and no batteries are required for starting. These generating sets can be furnished for operation with gas or kerosene instead of gasoline (petrol) if preferred, and generators may be had for all voltages.

The sets are sold by the B. F. Sturtevant Company, Hyde Park, Mass.

The White Mechanical System of Burning Fuel Oil

The White mechanical fuel oil burner, manufactured by the Washington Engine Works, New York City, is a simple device, consisting of an arrangement (Fig. 1) for driving the oil along a cone so that its velocity will not be retarded and impinging it on a second cone with a finer angle, thereby causing it to be delivered from the burner orifice in a very fine spray, which can be ignited with the oil at a pressure of from 20 pounds up. The pressure generally used on the oil is from 60 to 80 pounds. The flame commences at the end of the burner, and it is claimed the fuel is completely consumed in the furnace itself, resulting in a freedom from smoke even when using the heaviest of oils. A special feature of the device is the manner in which the air admission is regulated, and also the manner of completely closing off the air supply when the burners are not in use, so that the danger of leaky tubes and seams in the combustion chamber is eliminated.

When applied to natural draft boilers the arrangement (Fig. 2) consists of an air-heating front, which is fitted over the mouth of the furnace and formed by a disk casting having a number of projecting vanes forming air passages. The air enters at the periphery of the disk, and passing down these passages absorbs heat from the vanes and disk, becoming heated to a high degree of temperature before coming in contact with the atomized fuel. The vanes in this furnace front conduct the air to the center of the disk, where it is admitted to the furnace, surrounding the burner, which is fitted with a perforated jacket and a sliding cone, which can be regulated to supply the required quantity of air. When applied to marine boilers fitted with the Howden system of forced draft, the doors are the only part removed from the furnace fronts, and the White door, carrying the complete oil fuel burner installation, is fitted in its place. In this installation (Fig. 3) the air passages are cut in the side walls of the furnace casting, and the air is conducted to the center surrounding the burner.

In burning fuel oil by the mechanical spraying system, the oil is first heated to 150 degrees, and in some cases to 260 degrees F., according to the oil used. The oil heaters used in this system are of special design, and before the oil is delivered to the burner it is, of course, passed through filters or strainers, which are also of special design.

The advantages of this system are attributed in a large measure to the heating of the air supply, the control adjustment of the air supply, and the method of mixing the air and

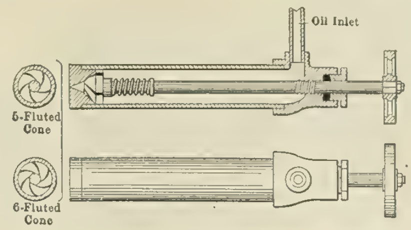


FIG. 1.—WHITE MECHANICAL OIL BURNER

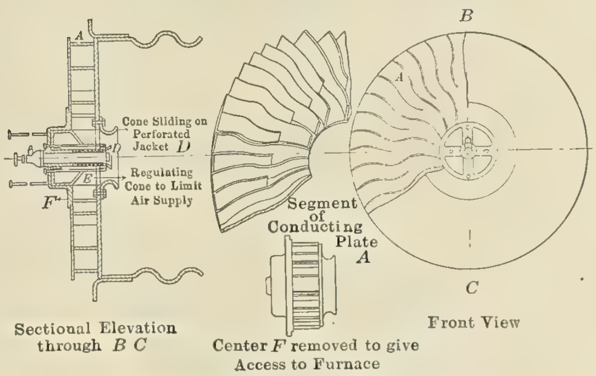


FIG. 2.—ARRANGEMENT FOR NATURAL DRAFT

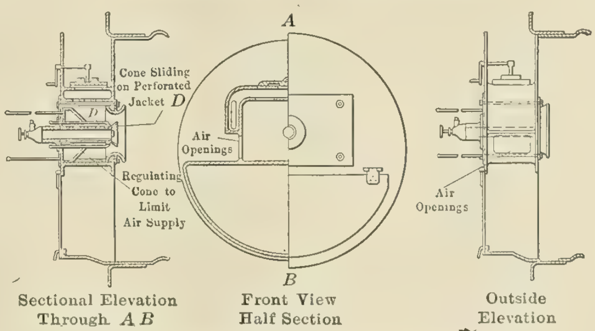


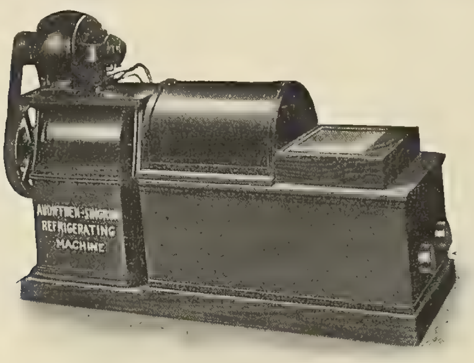
FIG. 3.—ARRANGEMENT FOR HOWDEN'S FORCED DRAFT

fuel, resulting in complete combustion in the furnace itself and the eliminating of smoke at the stack. No brick work is found necessary, and none is used, thereby tending to promote the circulation of the water in the boiler. The feature of using radiated heat from the furnace mouth to heat the air has a further advantage by giving a remarkably cool stokehold. Tests show a fuel consumption of only .93 pound per horsepower-hour.

Audiffren-Singrun Refrigerating Machine

The Audiffren-Singrun machine illustrated is a practical ice-making and refrigerating machine, designed to make from 11 to 110 pounds of ice per hour, according to its size, and it can be used for a combination of refrigeration and ice making. When used for refrigeration it connects readily with any type of ice-box. The machine operates on the compression system, using sulphur-dioxide as its refrigerating agent.

The machine is simple in construction, the principal parts consisting of simply a shaft carrying at one end a drum, on its middle another drum, and on its opposite end a pulley, gear or other means for revolving it. Its appearance is practically that of a large dumb-bell, and when it is in place the end drum is in contact with water, brine or other liquid to be cooled. The dumb-bell is sent out from the factory completely charged and ready to operate. The air is entirely exhausted, and the charge of sulphur dioxide and pure neutral oil is admitted, after which the machine is hermetically sealed. When



operating, the working parts are constantly lubricated, as pressure in the cylinder is constantly forcing oil between the working surfaces of the compressor.

Refrigerators cooled with the Audiffren-Singrun machine can be maintained constantly at a temperature of 35 to 40 degrees, which, together with an almost total absence of dampness, makes the refrigerator highly sanitary. Practically any one can run the machine, as for operation it is simply necessary to turn on the water and the power, which is usually supplied by an electric motor. There is nothing to get out of order, no connections to leak, and the pressure is not sufficiently high to cause an explosion in event of accident from any external cause.

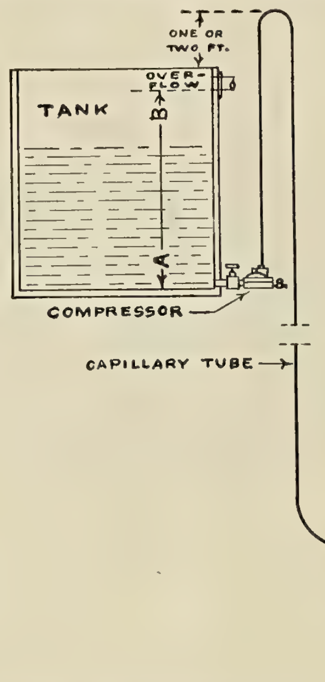
This machine is a French invention which has been on the market for a number of years with satisfactory results. The H. W. Johns-Manville Company, New York, are the selling agents in the United States.

The Hydro-Cator

A new hydraulic indicator called the Hydro-Cator is manufactured by the Sterling Gauge Company, Detroit, Mich.,. This instrument is used for indicating the depth of water or other liquids, and can be located any distance above, below or from the liquid to be indicated. It is adapted for tanks of all kinds, such as water, fuel oil, settling tanks and water compartments in floating dry docks and cranes, also ballast tanks, etc. The instrument itself is very simple, being free from any mechanism or moving parts, it shows at all times the exact amount of water in the tanks of compartments, in feet and inches or gallons.

The contents of the tank is shown by a brilliant red liquid or mercury in a glass tube, the scale reading is ten inches high for the standard instruments, which represents the full depth of tank, whether it is 2 feet or 100 feet, as each gage is specially calibrated for the depth of tank and the specific gravity of the liquid to be indicated. The manufacturers make them up with longer glasses up to 72-inch readings if desired.

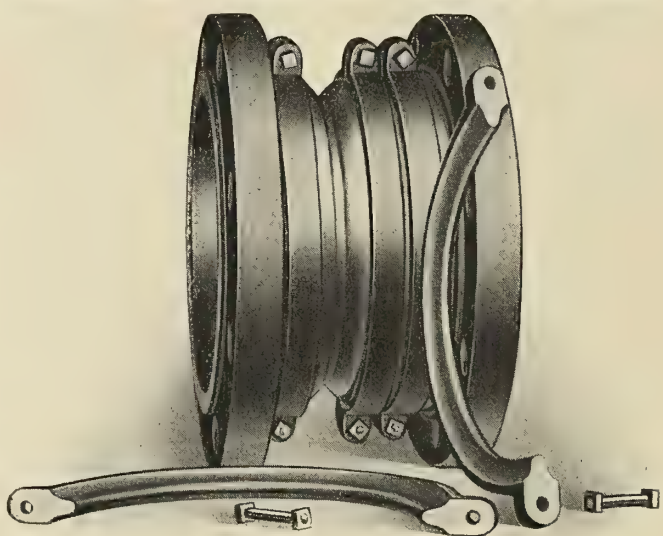
The instrument is fastened to a wall or bulkhead, and a ⅛-inch outside diameter capillary copper tube, annealed and very flexible, is run to the tank. The tube contains only air and can never freeze or stop up. One end of this hollow wire is attached to the top of a casting 6 inches in diameter, which is called the compressor, and is attached to the bottom and outside of the tank as shown, or may be simply lowered through the top to the bottom on the inside. The static pressure of the liquid in the tank forces the trapped air in the compressor and tube line against the indicating liquid in the instrument and causes it to rise in the glass tube in exact proportion to that in the tank. The apparatus can be installed



without emptying the tanks of their contents, and it is charged any time by attaching a standard bicycle tire pump to the cap on top of the instrument. One valuable feature is that the readings of the instrument are not changed or disturbed by any listing or racing of the boat in a heavy sea. The United States Navy are now specifying and have a large number in use.

The Badger Self-Equalizing Expansion Joint

The Badger self-equalizing expansion joint, made by E. P. Badger & Sons Company, Boston, Mass., is a corrugated



copper joint having external rings. It is designed to take up changes in length in pipe lines, whether these pipe lines convey steam, water or air. The well-known corrugated form, such as used for furnaces of internally-fired marine boilers, is adopted because of its strength and flexibility. External rings on the corrugations, besides adding to the strength of the joint, distribute the strains among several corrugations, and by thus bringing many corrugations into service no one of them is called upon to take more than its share of the work. The number of corrugations depend upon the pressure and upon the length of the joint. For high-pressure and superheated steam the change in length is considerable, therefore more corrugations are used. For very low pressures, as in exhaust piping, two or three corrugations are sufficient for the slight alteration in length.

The Francke Flexible Coupling

The Francke flexible coupling, shown in Fig. 1, which is sold by the Smith-Serrell Company, Inc., 90 West street, New York City, is simply an ordinary flanged coupling conected by flexible pins instead of rigid bolts, the faces of the flanges being slightly separated. The flexible pins, details of which are

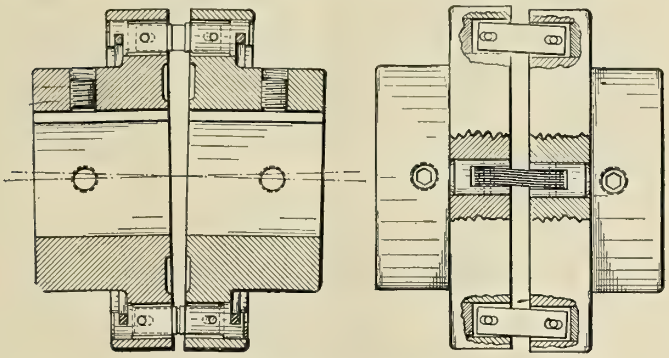


FIG. 1.—SECTIONAL VIEWS OF FRANCKE COUPLING

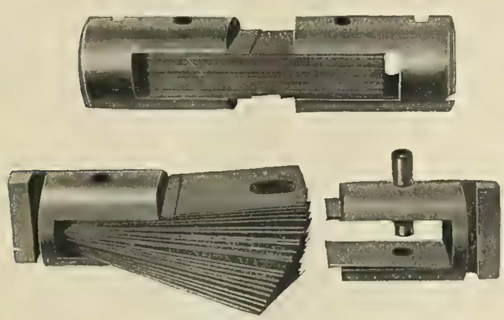


FIG. 2.—FLEXIBLE PIN

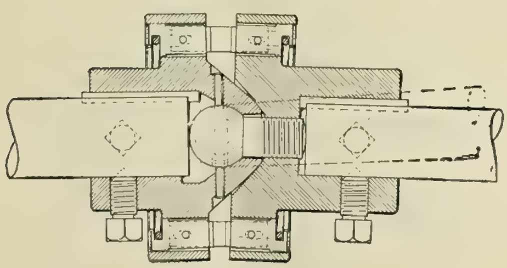


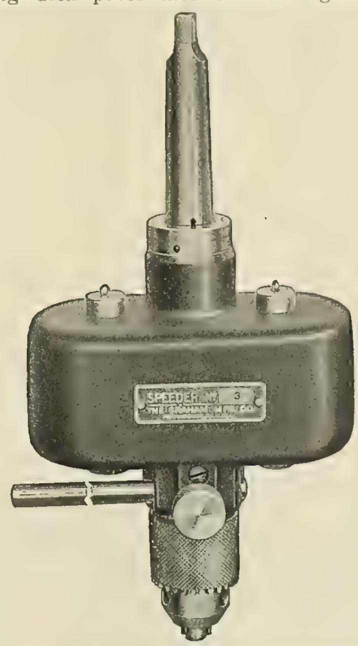
FIG. 3.—MOTOR BOAT COUPLING

shown in Fig. 2, are built of laminated clock steel springs united at each end by a soft steel keeper. The long leaves with the elongated hole do the driving, while the short ones are simply used as shims between the driving leaves and the soft steel keepers. No strain comes on the hardened steel cross pins, which are pressed into the keepers to make the whole pin an easily handled unit. A snap ring holds the keeper stationary in the flanges, yet the long leaves are free to slide, rock or bend, and thus with a very slight movement between the hardened steel surfaces take care of any accidental misalinement.

The Francke flexible coupling has been used on auxiliaries, such as pumps, fans, motors, dynamos, steam turbines, steam and gas engines, hoists, etc., in sizes up to 10-inch shafts. Larger sizes are in preparation to handle any size shaft in use, while it is intended in the near future to adapt the coupling to the shafts of ocean steamers, as, for instance, in the connection between a steam turbine and the pinions of the reduction gear. A special type, known as the motor boat or marine type (Fig. 3), is made which differs from the standard type, in that it will transmit the propeller thrust straight through the coupling to the main thrust bearings, which are usually a part of the engine, in sizes under 200 horsepower. This type of coupling is built for shafts from ¾ inch to 4 inches diameter.

New Drill Speeders

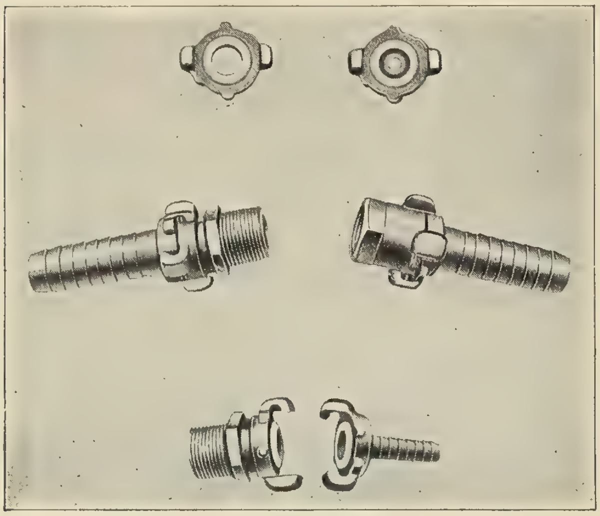
The Graham Manufacturing Company, Providence, R. I., has just brought out a new line of drill speeders, or high-speed drilling attachments, for use in drill presses of the larger class where small holes are to be made. The device increases the speed of the drill three times, and thus converts a slow-running drill press into one of high speed, thereby



saving the cost as well as the space required for an extra high-speed machine. The general type is shown in the illustration. The shank is made in standard sizes to suit the holes in ordinary drill presses. On the bottom is fastened a regular drill chuck, which revolves three times to once of the spindle of the main machine. Instead of the chuck the spindle may be extended and made to accommodate taper shank drills. The driving mechanism that increases the speed consists of gears and pinions arranged in double, so that side strains are eliminated. No end thrust is conveyed through the case. A ball-bearing between the bottom of the slow-revolving shank and the top of the fast-running spindle relieves all end strain. The alinement, which is quite important, is accomplished by extending the lower end of the shank downward inside the hollow chuck spindle until it is nearly as low as the bottom of the case itself. The spindle is further supported by a bronze sleeve on its outside.

The Chicago Hose Coupler

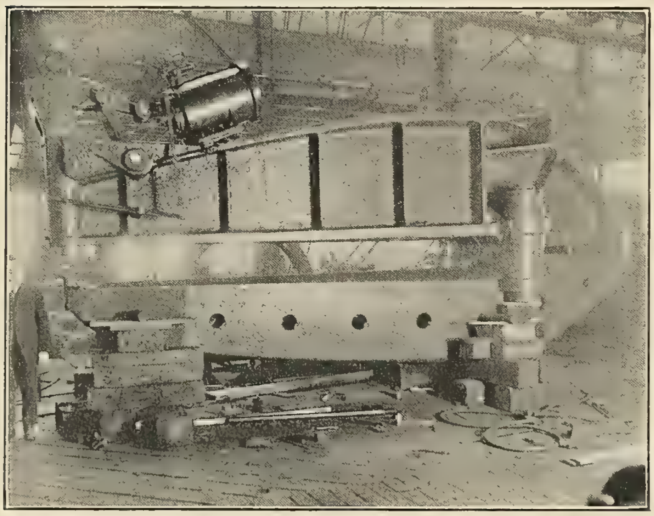
The Chicago hose coupler, manufactured by the Chicago Pneumatic Tool Company, Chicago, Ill., is a universal coupler made of tough bronze which cannot corrode, and which, it is claimed, makes an absolutely tight joint. As can be seen from the illustration, neither half of the coupler is male or female, but a combination of both, so that any size of hose can be coupled to any other size of hose, whether it be larger or smaller. The gaskets are made of pure rubber, and are so



arranged that they cannot blow or fall out, so that no time will be lost in looking for washers. The couplers are manufactured for male or female thread pipe size, as well as for hose from ⅜ inch to 1 inch.

Hanna Compression Yoke Riveter

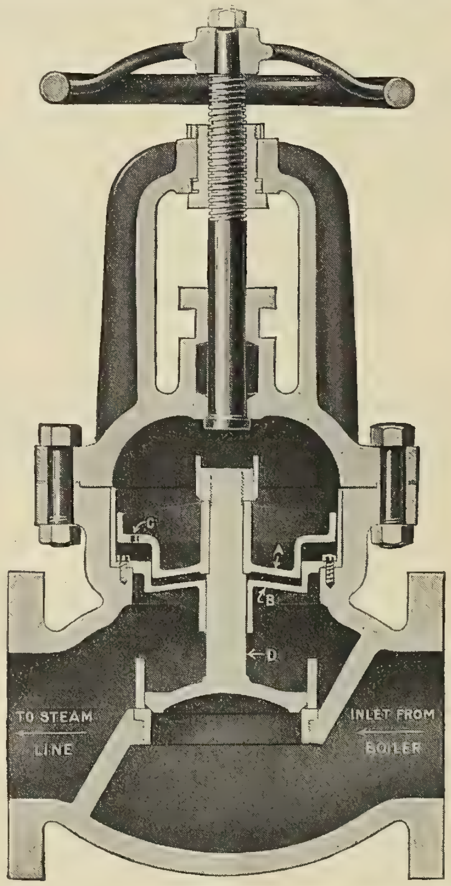
The Vulcan Engineering Sales Company, Chicago and New York, who control the entire product of the Hanna Engineering Works, recently furnished the General Electric Company, Pittsfield, Mass., with a Hanna type compression yoke riveter, weighing 56,000 pounds, for the riveting of transformer cases. This riveter has a reach of 168 inches, a gap of 12 inches, and exerts a pressure of 100 tons on the rivet with 100 pounds air



pressure in the cylinder. The size of the cylinder is 18 inches diameter, 22 inches stroke, and the movement of the plunger and upper die is 5¾ inches. Of this distance 4¾ inches is traversed during the first 11 inches of the stroke of the air cylinder piston, and the last 1 inch (under approximately uniform pressure and movement) during the last 11 inches of the stroke of the air cylinder piston. This last 1 inch of uniform travel and pressure, it is claimed, gives the machine all the advantages of the hydraulic riveter with the added advantage of low air pressure for actuating the mechanism instead of hydraulic pressure, usually from 1,000 to 1,500 pounds to the square inch. The machine also has the advantage of exhausting into the atmosphere without special provision of exhaust pipe, as is required with the hydraulic machine. These advantages will be readily appreciated by those familiar with the objectionable operating features incident to excessive hydraulic pressure and the difficulty of taking care of the discharge water. But its marked advantage over the hydraulic riveter is in the fact that the air gap is closed at high speed (under the toggle lever action), while the rivet is headed and finished at very slow speed (under the plain lever action), thus giving the plates ample time to adjust themselves and the metal in the rivet to flow sufficiently to fill thoroughly the hole and for the head to set. The fact that the entire travel of the plunger and upper dies in a hydraulic riveter is at a uniform speed necessitates the conclusion that a speed which is economical for closing the air gap is too fast to finish and head the rivet, if the best possible results are obtained.

Anderson Double-Cushioned Non-Return Valves

The Golden-Anderson Valve Specialty Company, Pittsburg, Pa., has on the market a double cushioned automatic non-return valve of both the globe and angle type. The construction of the valve is apparent from the sectional view shown herewith. When the hand-wheel is run down into the closed

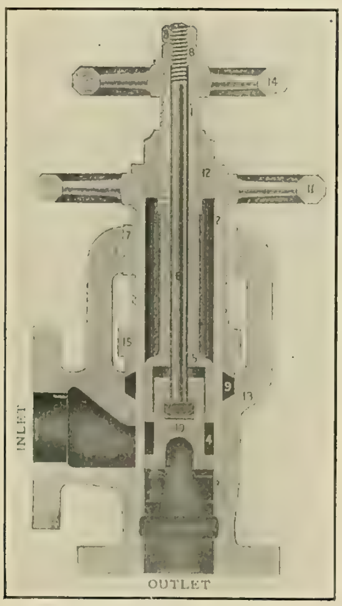


position the valve is shut like any globe valve. The hand-wheel stem, however, merely bears against the valve stem and is not attached to it, so when raised to the open position the valve disk is free to rise and fall under the action of the steam. To the upper end of the valve stem is attached a piston that creates a dash chamber in the top of the valve body above the liner. Through this liner the valve stem passes loosely enough to permit entrance of full pressure to the cushion chamber above the liner and through a small hole in the piston to the chamber above. Steam flowing into the header raises the valve and holds it open so long as the flow continues. If the flow ceases quietly, as when the fires are drawn, the valve settles on to its seat and remains closed against the header pressure. Sudden reversal of steam flow in case of rupture or other accident in the boiler tends to close the valve instantly. This it would do with destructive force were it not for the dash-pot and the cushioning device above the liner. The Corliss dash-pot method of cushioning is employed, occupying the full area of the upper portion of the body of the valve, thus insuring a positive cushion in the opening and closing of the valves and perfect alinement with the seat at all times, regardless of position. The hole through the dash piston permits rapid escape of steam to the chamber above and a quick drop of the valve to within about ⅛ inch of its seat, when the closer fitting secondary cushion comes into action as the lower portion of the piston enters the corresponding depression in the liner, forming a chamber from which the pressure can escape only gradually. The full boiler pressure is always above the dash-pot and the valve will close, at the same time being cushioned in the operation.

These valves are made extra heavy for a working pressure of 350 pounds per square inch. When placed in the boiler outlet the valve will permit the passage of steam to the header or main as required in regular service, but will close quickly against the reversal of the flow of steam. In case of accident to the boiler this valve will isolate the disabled unit from the rest of the battery, thereby not only reducing the destructive results of the accident, but also confining the damage to this one boiler, and avoiding oftentimes the necessity for any interruption in the operation of the rest of the boilers in the battery.

The Eynon-Evans Blow-off Valve

The Eynon-Evans Manufacturing Company, Philadelphia, Pa., has on the market a heavy flanged, nickel blow-off valve, built for the heaviest service. The illustration shows the valve in a closed position. The inlet is connected to the blow-off pipe from the boiler. The body and yoke of the valve



are of iron cast in one piece. A special nickel ring, 3, is secured in the iron body, the inside diameter of which is the same as the inside diameter of the bronze shield, 2, forming a continuous surface for the reception of the packing, 4. This packing is so placed in the ring and shield that it prevents leakage from the inlet to the outlet and around the bronze stem, and can be adjusted or compressed to the desired density while the valve is in service. The upper hand-wheel withdraws the pistons with the packing from the nickel ring into the bronze shield. The shield itself is operated by the lower hand-wheel. The principle involved is that of absolutely protecting the packing inside the shield before the grit, scale and other destructive blow-off products are permitted to pass through the valve from the boiler. The lower end of the shield also acts as a valve, which permits the removal and inspection of the packing, while the blow-off valve is in service with full boiler pressure.

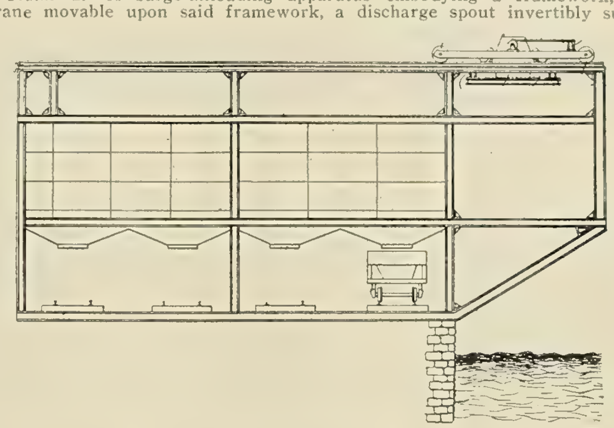
SELECTED MARINE PATENTS

The publication in this column of a patent specification does not necessarily imply editorial commendation.

American patents compiled by Delbert H. Decker, Esq., registered patent attorney, Loan & Trust Building, Washington, D. C.

1,055,788. BARGE-UNLOADING APPARATUS. EDWIN R. ORBIN, OF DUQUESNE, PA.

Claim 1.—A barge-unloading apparatus embodying a framework, a crane movable upon said framework, a discharge spout invertibly sup-



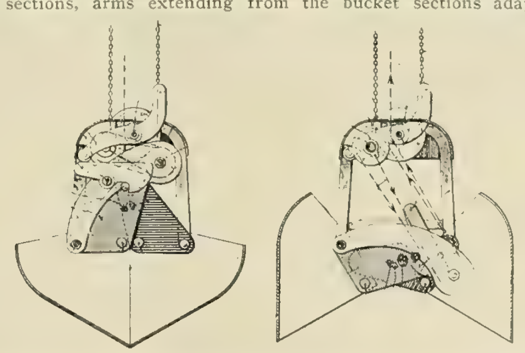
ported by said crane, an elevator suspended from said spout and adapted to be lowered to receive a barge and means for raising and lowering said elevator to and from said spout. Nine claims.

1,055,371. DREDGE. JAMES M. THORP AND VERNOR E. THORP, OF ALAMEDA, CAL.

Claim 1.—In a dredge, the combination of a swinging frame, means to swing the frame, and intermediate connecting mechanism adapted to reduce the rate of motion of the frame during its forward movement, said intermediate mechanism consisting of the arm pivoted to the barge and connected with swinging means and the arm connecting the arm with the swinging frame. Ten claims.

1,058,028. CLAM-SHELL BUCKET. CHARLES BERGHOEFER, OF MILWAUKEE, WIS.

Claim 1.—A bucket comprising a pair of bucket sections, a hanger frame, a pivotal connection between the hanger frame and each of the bucket sections, arms extending from the bucket sections adapted to



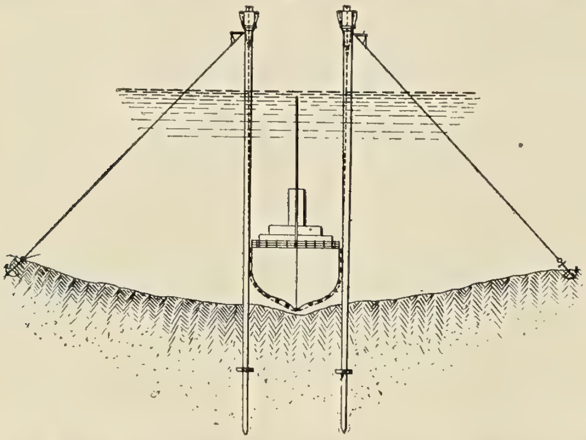
overlap each other intermediate of their fulcrum points, the arms being provided with angularly disposed slots, a rod connection engageable with the arm slots, a bail connecting the arms of one of the bucket sections, a grip-lever having one end fulcrumed to the hanger frame, a snatch-dog carried by the lever for engagement with the bail, a cable in connection with the free end of the grip-lever, whereby the same is actuated, and a tripping mechanism for the snatch-dog. Six claims.

1,058,539. GRAB-BUCKET. WILLIAM H. BOTTEN, OF CLEVELAND, OHIO, ASSIGNOR TO THE OWEN BUCKET COMPANY, OF CLEVELAND, OHIO, A CORPORATION OF OHIO.

Claim 1.—In a grab-bucket, a pair of pivoted bucket jaws, a bucket head to which the jaws are connected, a counterweight at the pivotal axis of the jaws, and means for opening and closing the jaws, said counterweight comprising a main portion permanently fastened in position and having the bucket closing means connected to the top thereof, and a plurality of jackets removably secured to said main portion and extending along the same substantially sides of the attachment to the bucket closing means. Five claims.

1,061,213. MEANS FOR RAISING SUNKEN VESSELS. JOHN ARBUCKLE, OF NEW YORK, N. Y.; CHRISTINA ARBUCKLE AND CHARLES A. JAMISON, ADMINISTRATORS OF SAID JOHN ARBUCKLE, DECEASED.

Claim 1.—In apparatus the combination of a series of piles, lifting means supported upon said piles and flexible connections passing over



the top of said lifting means and adapted to exert a central or longitudinal thrust on said lifting means and connected to the vessel. Twelve claims.

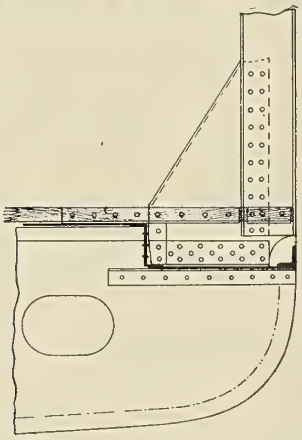
1,061,088. RUDDERS FOR THE SUBMERSION AND THE NAVIGATION OF SUBMARINE VESSELS UNDER WATER. CESARE LAURENTI, OF SPEZIA, ITALY, ASSIGNOR TO FIAT-SAN GIORGIO, SOCIETA ANONIMA, OF SPEZIA, ITALY.

Claim 1.—A submergible vessel, comprising a hull and a depth controlling rudder having a fixed angle of inclination less than a right angle from a horizontal plane, said rudder being adapted to be drawn within or protruded out of said hull. Seventeen claims.

British patents compiled by G. F. Redfern & Company, chartered patent agents and engineers, 15 South street, Finsbury, E. C., and 10 Gray's Inn Place, W. C., London.

2,907. AN IMPROVEMENT IN THE CONSTRUCTION OF SHIPS. J. CARMICHAEL, OF EAGLESCLIFFE, R. S. O., DURHAM.

The improved construction of ships is characterized by the fact that the tank marginal plate, which is placed in a horizontal position, is so connected with the tank top as to form a recess along the ship's side



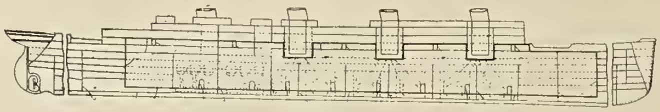
adapted to accommodate a gutter or bilge waterway or drainage and for securing the bottom edge of the gusset plate or Isherwood frame with or without a double angle bar connection between the gusset plate and tank top.

2,388. SHIPS' DAVITS. M. TEERLING OF LANDSTRAAT, DELFZYL, HOLLAND.

This invention relates to a ship's davit in which the jibs have their lower ends mounted on wheels or runners and running in constant rolling contact upon quadrant bars fixed in position to form suitable tracks for the runners or wheels. The jibs are supported and guided in their jiblike movement by working in slots in the girder bars of side frames as directed by the tackle provided for the purpose, the davit tackle being operated from one drum shaft and the boat tackle from another, the former passing over a pulley on the end of a staunchion projected from each of the jibs of the davits and the latter being adjustable in its line of pull on the jib by sliding bars, adapted to be projected as required from the girder beams of the side frames. The arrangement enables the apparatus to work by gravity derived from the load in the boat and the boat to be swung out clear of the ship's side.

10,468. IMPROVEMENTS IN SHIPS. A. E. MUIR, OF 10 GILLSIDE GROVE, SUNDERLAND.

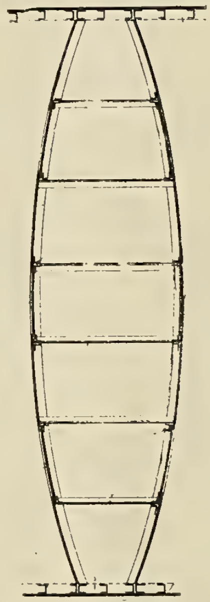
In order to provide a ship that will be as far as practicable unsinkable, transverse bulkheads are provided at suitable intervals for dividing the vessel into a number of separate watertight compartments, and there is also provided a central longitudinal buoyancy chamber of such dimensions and capacity that, in the event of the vessel being holed or damaged throughout a considerable portion of its length and a correspondingly large number of watertight compartments being rendered ineffective, the vessel will, owing to said chamber, still have sufficient buoyancy to remain afloat. The sides of the chamber extend vertically from the bottom of the vessel to any suitable height, but the bottom of the chamber is



arranged some distance above the inner bottom or tank top so as to constitute two double bottoms to the chamber for the purpose of rendering it invulnerable in the event of the double bottom of the vessel being holed. Passages are provided through the chamber in the engine rooms, boiler rooms, etc., for the purpose of giving access from one side of the chamber to the other, and in the event of any of the compartments being holed for allowing the water entering the same to flow to the other side of the chamber to preserve the trim of the vessel.

10,867. STRUCTURE OF STEAM SHIPS AND OTHER VESSELS. R. OSWALD, OF RIVERVIEW, BEACONSFIELD ROAD, BLACK HEATH, LONDON.

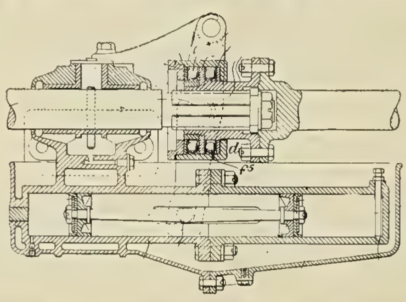
The sides of a ship have arranged between them a double bulkhead, the two parts of which are horizontally arranged, with their concave faces towards each other and are strengthened by angle bars and by



cross-bars or girders and vertical angle bars. Doorways are formed in the bulkhead. Instead of being outwardly curved, the bulkheads may be inwardly curved and nearer together at the center than at the ends, or instead of being curved they may be of triangular formation. The vessel may have two skins between which a space is left so that should the outer or main skin be fractured the vessel will remain watertight by means of the inner skin.

19,169. DRIVING GEAR FOR BOATS. DAIMLER-MOTOREN-GESELLSCHAFT, OF FABRIKSTRASSE, UNTERTURKHEIM, GERMANY.

In driving gear for boats the propeller shaft is mounted so as to be axially movable in relation to the driving shaft, and a cataract regulator,



or fluid or liquid brake or dash-pot device, is inserted between the two shafts for the purpose of reducing or nullifying shocks. The propeller shaft is connected with a lever mechanism which transmits the axial movements of the propeller shaft to one part of the cataract regulator device which has a regulatable inlet and outlet port and is arranged in a trough or container from which it sucks, or to which it delivers, the fluid or liquid used in the device.

International Marine Engineering

Published Monthly by ALDRICH PUBLISHING CO.

17 BATTERY PLACE, NEW YORK — 31 CHRISTOPHER ST., LONDON, E. C.

H. L. Aldrich, President and Treasurer
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Associate Inst. N. A.

Edited by H. H. Brown, A. M. Inst. N. A.
Member Soc. N. A. and M. E.

Vol. XVIII — JULY, 1913 — No. 7

Hudson River Steamer Washington Irving

The large side-wheel steamers plying on the Hudson River between New York and Albany are a distinctively American development in naval architecture. Ever since the enterprising inventor, Robert Fulton, demonstrated the commercial success of steam navigation on this waterway over a century ago with his diminutive *Clermont*, the Hudson River, pre-eminently famed among the rivers of the world for its historical associations and the grandeur and beauty of its scenery, has been a fertile field for the exercise of American ingenuity and foresight in the development of a type of shallow draft craft which, in size, convenience and appointments surpass any other boats built for navigating protected waters anywhere in the world.

From small beginnings the steamship lines which now carry on the immense passenger and freight traffic on this waterway have evidenced a remarkable growth both in the volume of traffic handled and in the magnificent appointments of the boats that are built for this service. During the last seven years no less than three large side-wheel steamers have been added to the fleet of the Hudson River Day Line for passenger service only between New York and Albany, the latest being the *Washington Irving*, just placed in commission.

FIG. 1.—THE LATEST HUDSON RIVER DAY LINE STEAMER, THE WASHINGTON IRVING

The new vessel is a magnificent example of this purely American type of naval architecture. She is a unique carrier in every respect, and can rightly be designated as a floating pleasure palace of steel and glass. The design and construction of the boat combine the best scientific, practical and artistic skill of America. The designs were worked out by one of the foremost naval architects, Mr. Frank E. Kirby, together with the firm of J. W. Millard & Bro., of New York. The hull was constructed by the New York Shipbuilding Company, Camden, N. J., and the machinery by W. & A. Fletcher Company, Hoboken, N. J. The preliminary work in the design of the vessel also included a series of tests with various models in the model towing tank at the University of Michigan, Ann Arbor, Mich., by Professor Sadler, to determine the best form of hull with a minimum of wave-making resistance at high speeds in shallow water. As a result, the novel feature of a torpedo stern was adopted, and the results obtained since the boat has been in service amply justify the pains taken to secure the most economical form of hull.

The *Washington Irving* breaks the world's record for licensed carrying capacity, which was previously held by her consort, the *Hendrik Hudson*, and will transport 6,000 passengers comfortably at a speed of 23½ miles per hour through the water and have ample room to spare. The vessel is a refined creation from the tip of her graceful stem to her torpedo stern, and is at the same time a staunch and strong craft. Everything on board the ship is planned for the comfort, safety and pleasure of the passengers. No freight is carried, and there are no sleeping rooms on board the ship except the crew's quarters.

The hull, which is 416½ feet long over all, 84 feet beam over guards, 44 feet molded beam, 14 feet 2 inches depth and 8 feet 6 inches draft, is built of steel throughout, the general construction of the hull following very closely that of the *Hendrik Hudson* (described in detail in International Marine Engineering, May, 1906) except in the matter of

of fire protection which are provided, the risk of fire on such a vessel is reduced to practically nil.

Propulsion is by steel feathering paddle-wheels, 24 feet 6 inches diameter, each wheel carrying nine buckets 15 feet long and 4½ feet wide. The main engine is a three-cylinder compound inclined engine with cylinders 45, 70 and 70 inches diameter by 84 inches stroke, designed to develop 6,000 indicated horsepower at 38 revolutions per minute. Steam is supplied at 170 pounds pressure by four single-ended boilers, 12 feet 4 inches diameter by 11 feet 11 inches long, and two double-ended boilers, 12 feet 4 inches diameter and 22 feet long, operating under Howden's system of forced draft. The boilers are arranged in two athwartship fire-rooms, with bunkers along each side having a total capacity of 110 tons.

FIG. 2.—REPRODUCTION OF THE ALHAMBRA, USED AS A WRITING ROOM

scantlings, which differ in some respects on account of the difference in the size of the two ships. The framing consists of 4-inch bulb angles, spaced 24 to 30 inches apart, with web frames in compliance with the classification rules. The hull is subdivided by seven transverse bulkheads, and there are five decks, the strength and rigidity of which are secured by means of a system of stanchions between the decks. These are of steel, placed in rows spaced about 10 feet apart, extending practically the whole length of the vessel. By means of connections to the longitudinal girders and deck beams, the entire structure is thoroughly braced to withstand hogging and sagging stresses, thereby doing away with the unsightly hogging girders so prominent in the earlier boats of this class. Steel, asbestos and other fireproof materials are used throughout the hull and superstructure of the boat wherever practical usage will permit, and in all exposed places, such as the fire-rooms, galley, etc. In this way, with the ample means

The average coal consumption is 5 tons per hour. The auxiliaries include two Kerr turbo generating sets of 35 kilowatts each. All of the pumps throughout the vessel are of the Blake make.

The Irving period is made the basis for the interior design of the boat, and nineteen private balcony parlors are provided which are named after the States of Irving's time, while other saloons are modeled from the more artistic interiors of the first half of the last century. Throughout the various saloons will be found about fifty oil paintings sketched by well-known artists from the original locations of the subjects depicted as far as possible. These paintings not only give a peculiar charm to the decoration of the saloons, but they illustrate the life of Washington Irving, his time and his works.

A charming feature is the reproduction of the Alhambra, the relief and coloring of which have been reproduced from careful studies of the original made and adapted to the

FIG. 3.—UPPER DECK, LOOKING AFT

FIG. 5.—PRIVATE BALCONY PARLOR

steamer. Below the main deck, in the forward part of the hull, is a lunch room which has been faithfully patterned after the Old Cock Tavern of Fleet street, London, where Irving and his literary associates used to lunch. In another part of the vessel Irving's study at Sunnyside is copied and used as a ladies' lounge. The main dining room, which takes up the entire after part of the main deck, is furnished in pure Colonial style. The main saloon on the deck above is a blend from Moorish to Knickerbocker, but very tastefully treated. In size this forward saloon is said to be one of the largest rooms afloat.

The chief charm of the boat for the passengers, however, in summer is the immense outside deck area, there being in all about 2 acres of wide promenades and lounging retreats. Large plate-glass windows are fitted to all the rooms, so that a good view can be obtained by each passenger of the wonderful panorama along the Hudson River.

The subjects of the numerous oil paintings which are an attractive feature of the interior decorations of the boat were found entirely in Irving's writings and the scenes of his life. A comprehensive series of views of the Alhambra, painted by Herbert W. Faulkner, are placed in the main saloon. The series include sixteen paintings typifying Irving's long residence in Granada. A large view of Astoria, Ore., as it appeared in its early days when it was a trading post for John Jacob Astor's fur enterprises is found in the main saloon, together with another picture by the same artist, showing Bracebridge Hall on a snowy winter night. A series of eleven views of the Hudson River was supplied by Raphael A. Weed. These views show parts of the river not usually taken as subjects by painters, and for the most part show places of the upper Hudson with its little villages looking just as they did in

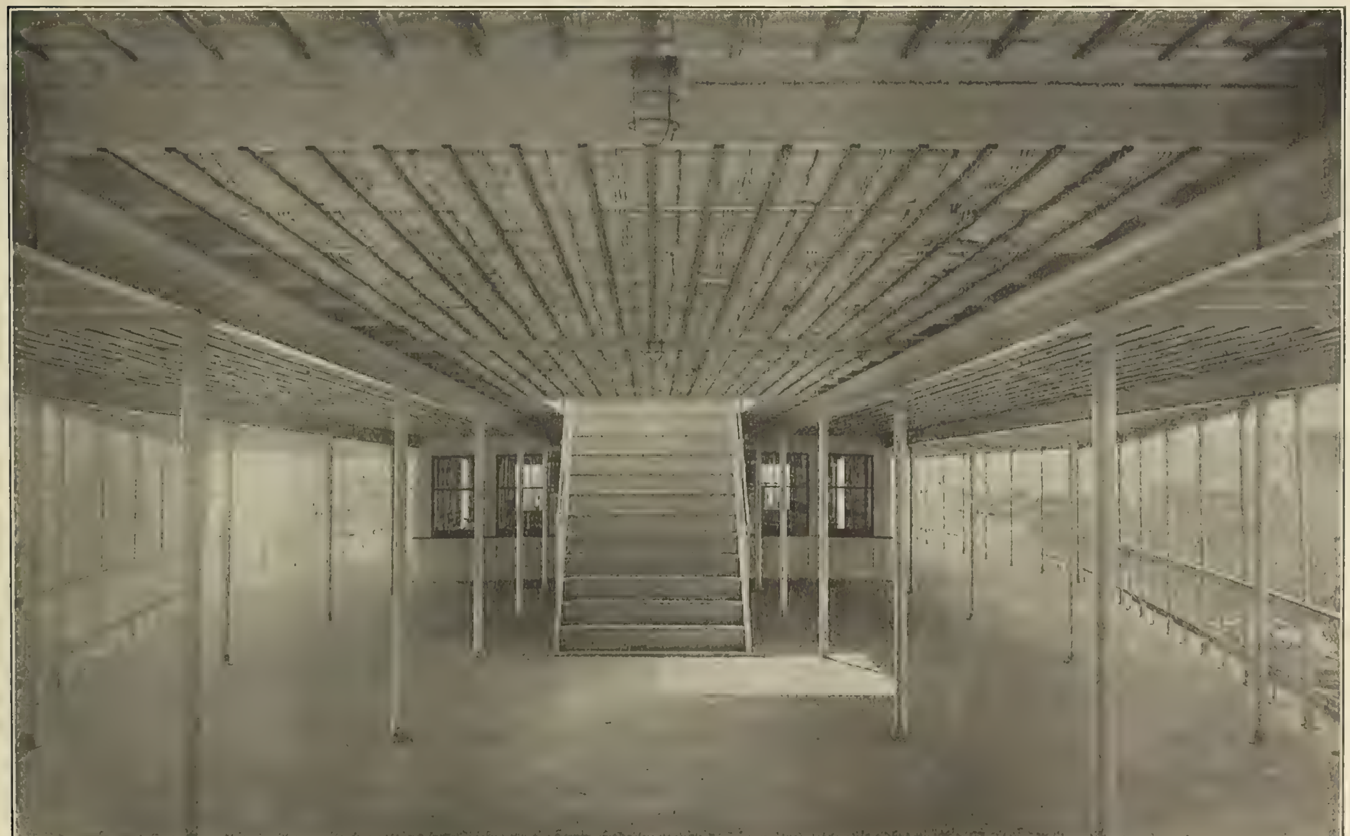


FIG. 4.—VIEW SHOWING WIDE PROMENADE SPACE ON DECK

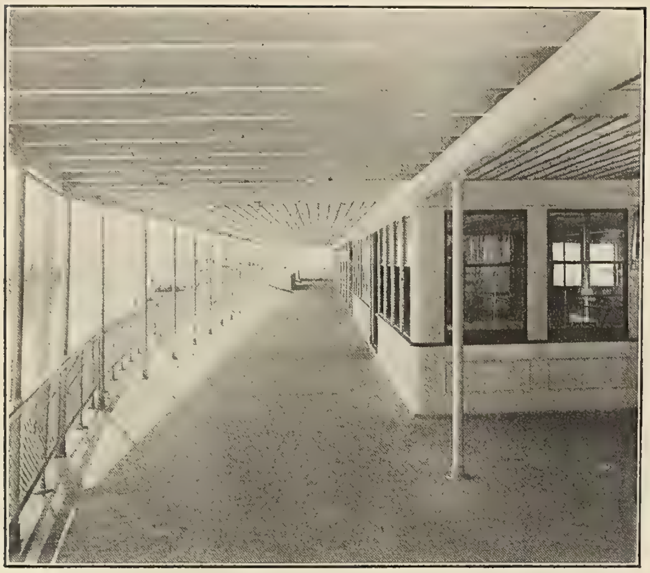


FIG. 6.—OBSERVATION DECK

FIG. 7.—PROMENADE DECK

FIG. 8.—MAIN DECK

FIG. 9.—LUNCH ROOM

Irving's time. One of the paintings, showing a glimpse of the Catskill Mountains from the heights above Castleton, a few miles below Albany, is said to depict one of the most beautiful views in this part of America.

In the main saloon will also be found a series of views painted by Mr. Weed, showing points in New York City associated with different periods of Irving's life, as, for instance, the Golden Hill Inn opposite his birthplace; St. George's Chapel in Beekman street, where he was christened; John Jacob Astor's country home at Eighty-sixth street and the East River, where Irving wrote "Astoria," and the Irving House at Seventeenth street and Irving Place. In the forward observation room, on the uper deck, is a long panoramic view of the Catskills, painted by Mr. Weed, while in the after observation room are paintings of the Sleepy Hollow church and other views. In the large dining saloon on the main deck are two large paintings, one on either side of the main entrance, showing the dining room at Sunnyside, Irving's home on the Hudson, and the dining room of the Red Horse Hotel at Stratford-on-Avon, where Irving lived for a long time.

Another artist whose work is found on the boat is the celebrated sculptor, Victor D. Brenner, who has a bas-relief portrait of Irving.

The commission for most of the paintings depicting the scenes from the Alhambra was given originally to S. Ward Stanton, formerly editor of the *Nautical Gazette*, who painted a number of the decorations for the *Robert Fulton* of the same line. After completing the sketches for these paintings last year, Mr. Stanton sailed for New York on the ill-fated *Titanic* and went down with the ship.

FIG. 10.—OBSERVATION ROOM

Large-Motor Vessels*

For the shipbuilders, and for the whole shipping trade, the large motor vessel question is by far the most momentous one of the day; its importance is as great as was that of the introduction of steam power some 100 years ago, the only difference being that technical improvements now make their way much more rapidly than they did a century ago.

Chief among the many new departures in ship propulsion which the last decade has brought us have been the watertube boiler, the turbine and superheated steam. Of these only the last-named has established itself in the merchant services, the two others being almost entirely confined to war vessels, and here and there only applied to fast passenger vessels. In contrast with these conditions the large motors will at once appeal to the merchant service, although the increase of power which they bring will be of great value to war vessels also.

The stage of development now reached is such that we must give our serious attention to the question, "Will the propulsion of sea-going ships in the near future or within a measurable time be effected wholly or for the most part by means of oil motors instead of by coal and steam?" The economical importance of this question may best be made clear by means of figures. Statistics of the total horsepower now in existence in merchant vessels do not exist, only the annual returns of individual countries in some cases giving the indicated horsepower totals of recent years along with those of the gross register tonnage. From these latter returns it appears that for every 10 gross register tons about 8 horsepower has in recent years been turned out; if a proportion of about 10 to 6 be taken for the whole of the merchant steamer fleets of the world, the engine equipments of the latter will work out at six-tenths of the 37,000,000 gross register tons given by Lloyd's Register, or in round numbers at 22,000,000 of indicated horsepower. The naval fleets of the world are credited in the various statistical compilations with indicated horsepower totaling up to 15,000,000. For the first cost of the engines of merchant steamers $36 (£7-10) per indicated horsepower may be taken as a low estimate, about $12 (£2-10) going to the shafting and to the auxiliary engines and $24 (£5) to the main engines and boilers. The corresponding values for war vessels must be placed higher, so that the total value of the main engines and boilers of sea-going vessels of all kinds amounts in round numbers to $975,000,000 (£200,000,000), which may within measurable time be for the most part rendered worthless by the advent of the oil motors.

A shifting of values of this revolutionary character can be brought about only by very considerable advantages attaching to the new mode of propulsion. In what, then, do the great disadvantages of the propulsion by the steam engine lie? From the point of view of the shipowner and the merchant the disadvantages are not so very great. For commercial purposes the ship is only a means to an end for the shipowner, the engine is only a necessary evil, and the less he hears of it the better he is pleased. For ocean commerce the steam engine fulfills its purpose; it has attained a high degree of reliability, and supplies of coal for it are obtainable at all important towns of the world. In general, then, the position is justified which I have found many managers of shipowning companies take up, that they are not by any means pleased at the prospect of the so-called "improvements," which, in the keen competition of the period of transition, will bring a series of very disturbing alterations in their train.

As has so often been the case in recent times, the movement has been set on foot by the engineers, who are constantly striving after the economically better. The disadvantages of propulsion by the steam engine are of a general character, and lie in the complicated indirect development of power, in which large losses occur by reason of the generation of the steam in the boilers. The endeavors of the engineer, from which the motors have sprung, are directed towards the abolition of this intermediate member and the direct development of power at the point where it is required, namely, in the engine itself.

What are the advantages which thereby accrue to navigation? The abolition of the boilers will be hailed with delight not only by the sea-going and superintending engineers, but also by the captains and owners. The boilers constitute a constant source of care and danger, and require large staffs for their working, the obtainment and management of which are beset with increasing difficulties. Even in the case of an ordinary merchant steamer, the allowances of weight and space for the boilers are considerable, while in large passenger liners and war craft they increase to such an extent as to determine the sizes of the vessels or the speeds of these on given dimensions. The sole reason why the *Mauretania* had to be so much larger than the fast liners of the North German Lloyd Line was that the large horsepower necessary for the attainment of 25½ knots in place of the 23½ knots of a vessel of the size of the *Kaiser Wilhelm II.* entailed an amount of boiler space which could not be obtained otherwise. In addition to the space and weight thus required comes the supply of fuel. As a result of the indirect development of power by the boilers, the average consumption of coal in the best steam installations is still at least 1.3 to 1.55 pounds per indicated horsepower per hour, that in the oil motor with its direct production of power being only about one-third as much.

The great advantages of the motor propulsion as compared with that by the steam engine are, then, the following: Great saving of space and weight in consequence of the abolition of the boilers and of the reduction of the consumption of fuel by one-third; to this comes the elimination of a large proportion of the stoker contingent. A large number of designs which, with the co-operation of the shipowners, have been got out during the last few months for some of the principal types of merchant vessels have shown favorable results.

Compared with a steamer, a motor merchant vessel in the European coasting trade saves about 10 percent in space and weight; in the long-voyage trades, such as those to South America and the Black Sea, the saving ranges up to 20 percent.

A sea-going fishing vessel with a motor can take fuel with her for twice the time that a steamer can, and in addition can make room for about 50 percent more fish.

The most marked differences, however, are shown by fast passenger liners. A fast passenger vessel of the size of the *Kaiser Wilhelm II.* can take in a motor installation of 60,000 indicated horsepower in place of the 40,000 indicated horsepower now carried, and will thereby attain a greater speed than the much larger *Mauretania;* at the same time she can take in sufficient oil in New York for the journey out and home, while under present conditions she has to coal both in Bremerhaven and in New York. Meanwhile, in spite of the 50 percent increase of power and the 100 percent increase of radius of action a considerable saving in weight is effected and the draft is thereby reduced.

Similar results are shown by war vessels, which cannot, however, be further gone into here.

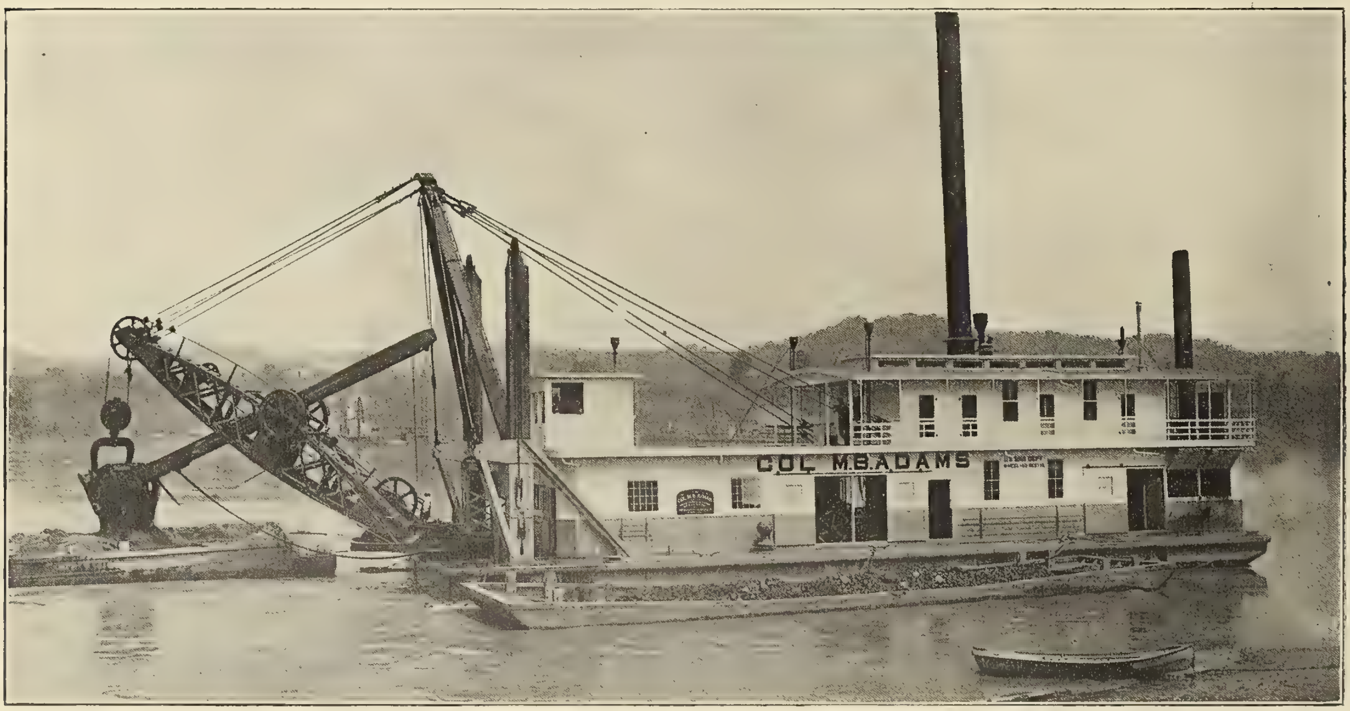
The advantages thus enumerated are so surprisingly great for almost all vessels that the end in view appears worthy of some effort; the only question is whether we are to-day so far advanced that installations of this character can be reliably carried out.

* From a paper read by Professor W. Laas at the III. German Ocean Navigation Day (III. Deutscher Seeschiffahrtstag), Berlin.

Col. M. B. Adams—A 4-Yard Dipper Dredge

BY ARTHUR F. KING

Last year the United States Government purchased a 4-yard dipper dredge for service on the Wheeling Division of the Ohio River. The machinery of the dredge is designed to have sufficient power to handle properly a 4-yard dipper in ordinary soft material and a 2-yard dipper of extra weight and strength in hard material, when working under a steam pressure of 100 pounds. Arrangements are made for digging to a depth of 25 feet below the surface of the water and all parts are designed with a view to ease in handling and speed in working, so that under ordinary conditions a speed of 40 to 50 seconds per bucket load is maintained, and so that the changing of spuds and moving up is accomplished in about one minute.



FOUR-YARD DIPPER DREDGE IN OPERATION ON THE OHIO RIVER

The hull is built entirely of steel and is 100 feet long, 34 feet beam and 7 feet 3 inches deep. The frame spacing is 24 inches, center to center, the floor and deck beams are 6 inches by 15.6-pound Z-bars; the frames 4-inch by 4-inch by 3/8-inch angles; the intercostal stringers are 4-inch by 4-inch by 3/8-inch angles and are set to support the angle frames. There are five watertight bulkheads distributed throughout the hull; also four longitudinal trusses running the full length of the hull. These trusses are built up of 6-inch by 15.6-pound Z-bars, 3/8-inch gusset plates and 4-inch by 4-inch by 3/8-inch angles. The object of the longitudinal trusses is to impart rigidity to the hull.

The shell plating consists of bottom plates 12.75 pounds, except the outer strake, which are 15.30 pounds; side plating, 12.75 pounds; bilge strake, 15.30 pounds; sheer strake, 15.30 pounds; bow and stern plates, 12.75 pounds; deck plates, 12.75 pounds; except outer strakes, which are 15.30 pounds, and bulkhead plates, 12.75 pounds.

Living quarters for the crew are located on the upper deck.

The hoisting and backing machinery is mounted on a steel frame built up of 24-inch I-beams, securely riveted together and kept in perfect alinement by braces and gusset plates. The engines are double, 13-inch bore by 16-inch stroke, of the horizontal type, the bed plates cast separately and mounted on either side of the under frame in line with the drum shaft bearings. These engines are fitted with a balanced piston throttle and the cylinders are lubricated by means of a force feed oil pump. The engine shaft is of hammered steel, 5½ inches in diameter. The hoisting and backing frictions are of the outside band type, actuated by steam, and the friction bands being lined with wood blocks seldom require adjustment, as the long stroke in the cylinder allows for considerable wear. The backing drum has a smooth barrel mounted on a 6-inch hammered steel shaft, set directly ahead of the engines. The hoisting drum is compound geared from the main engines through the backing shaft. It has a grooved barrel for 1⅜-inch rope and is mounted on a hammered steel shaft 7 inches in diameter. Both of the drums are provided with bronze bushings, removable in case of wear. All gears of the hoisting and backing machinery are of open hearth cast steel and have machine cut teeth.

Swinging Machinery

The swinging machinery is mounted on a steel frame, built up of 20-inch steel I-beams. The swinging engines are double, 9-inch bore by 9-inch stroke, reversible by a central valve of the balanced piston type. The two cylinders with their one steam chest form a single casting, bolted to the bed plate, which is also cast in a single piece. The crank shaft, on one end of which is keyed the cast steel pinion, is of forged steel, 4 inches in diameter. The engines are compound geared to the swinging drum through a 5½-inch hammered steel intermediate shaft, set directly ahead of the engines and fitted with steel gear and pinion. The swinging drum, which is 27 inches in diameter, is grooved for 1¼-inch wire rope and is keyed to a 5½-inch hammered steel shaft. All gears of the swinging machinery are of open hearth cast steel and have machine cut teeth.

Spuds and Spud Machinery

The forward spuds are of oak, in one piece, 25 inches by 25 inches by 50 feet long, reinforced at the corners by 6-inch by 6-inch by ½-inch angles full length. The spuds are operated in steel casings by 1⅜-inch cable connected with the spud drums. Each spud carries two sets of cables, one for hoisting the spud and the other for pinning up the dredge. When the dredge is pinned up the spuds are locked in position by means of a heavy brake band on the spud machinery.

The aft or trailing spud is 20 inches by 20 inches and is raised by a 1-inch cable connected to the aft spud drum and working singly. The spuds are equipped with cast steel points or shoes.

The forward spud machinery consists of two independent outfits, each mounted on a substantial steel frame, built up of 20-inch I-beams. The spud engines, which, in most respects, are similar to the swinging engines, are compound geared to the spud drum through a 5½-inch hammered steel intermediate shaft, set directly ahead of the engines. The intermediate shaft is fitted with a heavy brake band for locking the forward spuds. The spud drum is mounted on a 5½-inch hammered shaft and is grooved for 1⅜-inch wire rope.

The aft spud machinery is mounted on a steel frame, built up of 12-inch I-beams. The engines, which are double, 6-inch bore by 7-inch stroke, and in many respects similar to the forward spud engines, are compound geared to the spud drum through a 3½-inch hammered steel intermediate shaft, fitted with cast steel gear and pinion. The spud drum has a smooth barrel 15 inches in diameter and is mounted loosely on a 3⅞-inch hammered steel shaft. An inside expanding band friction throws the drum out of gear for dropping the spud. A brake band is fitted on the drum for holding the spud in any desired position. All gears and pinions of this machinery are of open hearth cast steel and have machine-cut teeth.

Dippers and Dipper Handles

Two dippers are furnished with the dredge, one of 4 and the other of 2 cubic yards struck capacity. Both dippers are of the most improved construction. The entire front of each dipper is a single manganese steel casting, extending from top to bottom, as well as around the corners, where it is securely riveted to the side plates. The front is fitted with four short teeth or points, no bases being used, since the heavy front castings take the place of the teeth bases. The two sides of the dipper are of ¾-inch plate steel, riveted to the manganese front and to the dipper back, which is a single open hearth steel casting. To the dipper back are secured the dipper handle, pitch braces and door hinges. All pinholes in the dipper subject to wear are provided with removable bushes, those in the door hinges and bail being of manganese steel.

There are two dipper handles, each composed of two oak members 7½ inches by 17 inches by 43 feet long. Each member is ironed with two 8-inch by 7½-inch by ¾-inch angles full length, forming the outside corners, and by two 6-inch by ½-inch bars full length on the inside of the handle. The racking is of manganese steel, bolted to the under side of each member to engage the shipper pinions. The end socket and adjusting castings are bolted to the handle for pin connection to the dipper backs, thus making provision for a change in the pitch of the dippers. The dipper handles are interchangeable and fit both dippers.

Boom, Yoke Block and Swinging Circle

The boom, built entirely of steel, is of the double bow type, 45 feet long between center of sheave at point and center of hinge pin at foot. The point and foot castings are of steel, securely riveted to the sides of the boom. The shipper shaft is of hammered steel, 6 inches in diameter for the yoke block and bearings and 6 inches square for the shipper pinions and brake wheels. The shipper shaft pinions are of manganese steel, engaging the manganese racking on the under side of the dipper handle, the handle being held to these pinions by means of a yoke or saddle block, consisting of a cast steel reach or separator block, joined by two yoke bolts of 3-inch round iron, to a steel frame carrying two sets of steel rollers grooved to clear the racking bolts. The bearings in this block are provided with interchangeable bronze bushes, removable in case of wear. The boom sheaves are 5½ feet in diameter of open hearth cast steel, being bronze bushed and having machine-turned grooves.

The swinging circle is 16 feet outside diameter and is mounted on the bow of the boat, revolving on a steel casting having a journal 45 inches in diameter. The circle is built up of ⅜-inch plates, securely riveted to the hub casting to which the foot of the boom is hinged and to which the cross braces supporting the I-beam rim are fastened. The swinging cables are fitted on the ends with long adjusting bolts to take up the stretch in the rope.

A-Frame, A-Frame Yoke and Guys

The A-frame is built entirely of steel with cast steel head and foot castings, and stands 34 feet in height above the main deck. The A-Frame is pin-connected to cast steel step castings, set on the forward spud casings. The head casting is of open hearth cast steel and is firmly fastened to the A-frame legs with turned bolts, which are slightly tapered, and is provided with a 7-inch journal pin for the A-frame yoke. The back of this casting has two large lugs to which the A-frame back guys are fastened by means of steel forgings. The A-frame and boom guys are of crucible steel galvanized wire rope, the ends of which are fitted with long U-bolts for adjustment to proper lengths.

Operating Levers

The levers for controlling the dredging machinery are mounted on the upper deck forward, and are grouped for convenient operation in the small cabin, as shown in the illustration. They include a lever for operating the main hoisting engine throttle valve, for the steam cylinder actuating the main hoisting friction, for the combined throttle and reverse on the swinging engines, for the steam cylinder actuating the friction of the backing drum, for each of the combined throttles and reverses of the forward spud engines, for operating each of the forward spud brakes, a foot pedal for operating the hoisting check band. One cranesman's hand and foot lever are located at the foot of the boom. The aft spud machinery is operated by one friction lever and one throttle lever located on the main deck, aft. The capstan levers are located near the capstans.

Boiler and Fittings

The boiler is of the locomotive type, 72 inches in diameter by 18 feet overall length, having a heating surface of 1,390 square feet. It is designed for a working pressure of 125 pounds, although it is intended to carry about 100 pounds when working. The stack, which is proportioned for natural draft, is 35 inches in diameter and stands 55 feet high from the top of the boiler. The boiler is, of course, equipped with shaking grates and the usual accessories—a 5¼-inch by 3½-inch by 5-inch duplex feed pump and an injector to supply feed water to the boiler. A No. 15 National Heater with 1½-inch feed pipe is placed in the boiler feed line. All steam pipes 1¼ inches and over are connected to the boiler by riveted flanges and all pipes 1¼ inches and over are connected by flanges. Valves under heavy pressure are of extra strength, those of 2½ inches and under being of brass. One 12-inch by 6-inch by 12-inch duplex brass-lined fire and bilge pump is furnished.

A three-ton chain hoist with a built-up steel frame is installed over the engines. The block is rigged up from a double beam running fore and aft above the machinery. This block is used when repairs are being made.

The dredge is used in general river service in which the requirements vary from common soft material to blasted rock, pulling out piling, old piers, etc. For the most part the dredge has served in the latter capacity along with digging recesses for locks. The dredge was built by the Marion Steam Shovel Company, Marion, Ohio.

Hudson River Steamer Berkshire

The latest addition to the splendid fleet of the Hudson Navigation Company, which furnishes night service between New York, Albany and Troy, is the steamer *Berkshire*, designed by J. W. Millard & Bro., naval architects, New York City, and built by the W. & A. Fletcher Company, Hoboken, N. J., by whom the contract for the hull was sublet to the New York Shipbuilding Company, Camden, N. J., and the contract for the joiner work and decorating to Charles M. Englis, successor to John Englis & Son, Brooklyn, N. Y.

The *Berkshire*, which is a five-deck steamer, 440 feet long by 90 feet beam over guards, resembles in general arrangement the other vessels of the Hudson Navigation Company's fleet, such as the *C. W. Morse*, the *Adirondack*, *Trojan* and the *Rensselaer*, all of which are noted for the artistic manner in which comfort, luxury and elegance have been combined in all the appointments. The passenger accommodation of the *Berkshire* comprises 450 staterooms, including many special suites with parlors and private baths.

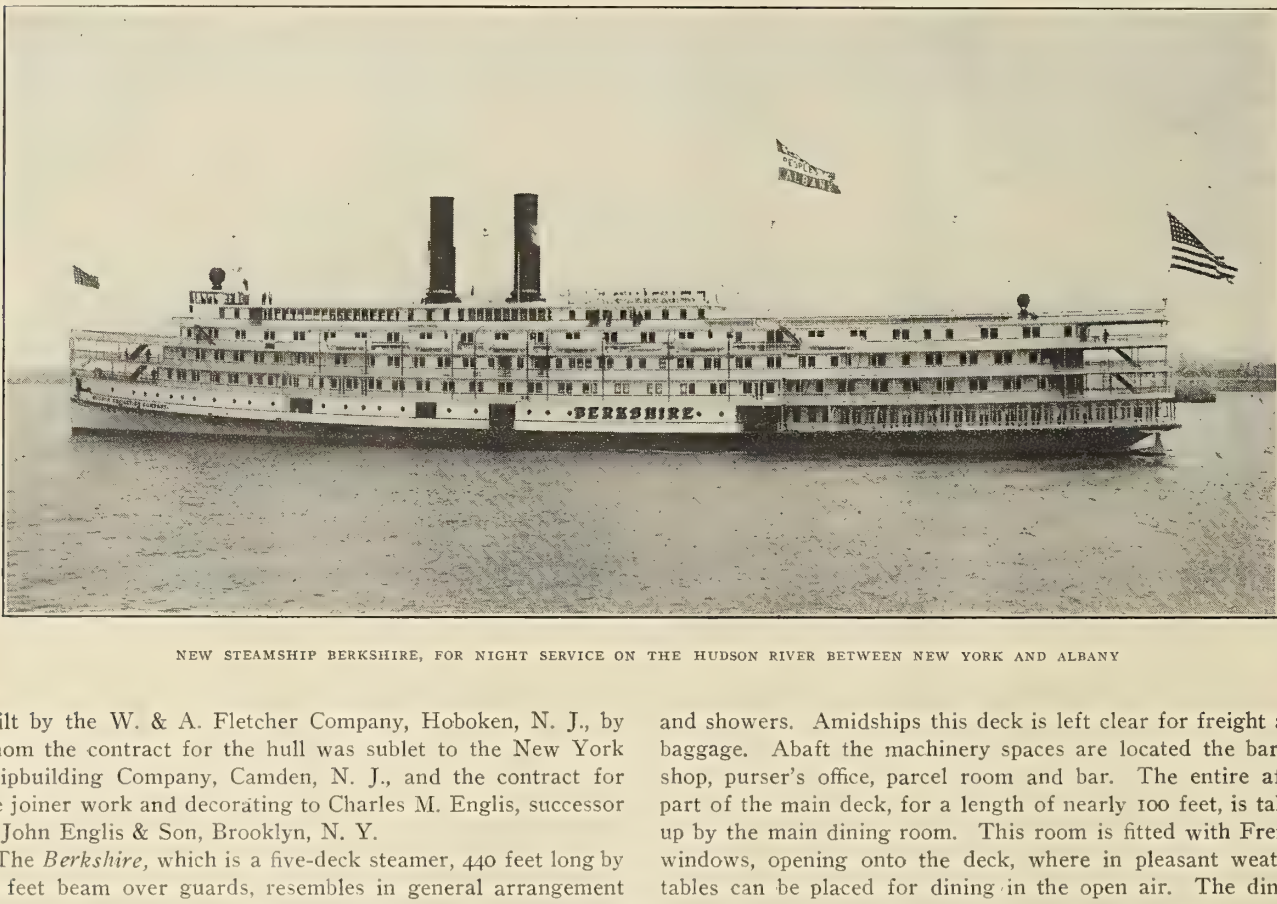
Propulsion is by side paddle-wheels of the feathering type, 30 feet outside diameter, each wheel containing twelve curved steel buckets, 3 feet 9 inches wide and 12 feet 11½ inches long. The main engine is a single-cylinder beam surface condensing engine, 84 inches diameter by 144 inches stroke, rated at about 5,000 horsepower. Steam is furnished by four lobster-back return tubular boilers with shells 9 feet 6 inches mean diameter by 34 feet 4 inches long, the front of the boilers being 11 feet 10 inches wide. The allowable safe working pressure is 55 pounds per square inch. The auxiliaries include a donkey boiler, three 50-kilowatt generating sets, furnished by the General Electric Company, and a very complete system of fire, wrecking and sanitary pumps. Protection from fire is secured by steel enclosures around the machinery spaces up to and including the observation deck.

The vessel has five complete decks, designated as the main deck, saloon deck, gallery deck, upper gallery deck, and the observation deck. In the forward hold are berthed the deck hands and firemen. Aft of this a space 40 feet long is reserved for the colored help, and next aft are accommodations for the white help. Abaft these accommodations are the dynamo room, containing three 50-kilowatt generating sets, the boiler room and then the engine room. Immediately abaft the engine room is the galley, and finally at the stern are accommodations for 46 men on the starboard side and for 44 women on the port side.

Above the hold on the main deck are limited accommodations forward for second class passengers, together with toilets and showers. Amidships this deck is left clear for freight and baggage. Abaft the machinery spaces are located the barber shop, purser's office, parcel room and bar. The entire after part of the main deck, for a length of nearly 100 feet, is taken up by the main dining room. This room is fitted with French windows, opening onto the deck, where in pleasant weather tables can be placed for dining in the open air. The dining room is finished in ivory-white with decorative panels.

The saloon and gallery decks are given over almost entirely to staterooms, including the special suites. A space just outside the inside rooms of the gallery deck provides light and air to the inside rooms of the saloon deck below. On the upper gallery deck, besides the staterooms, there is a splendid promenade space outside, and amidships is a ladies' writing room. The forward part of the observation deck is taken up with an observation room, finished in Circassian walnut, opening off from which is a ladies' parlor.

Among the special decorative features is a large panel at the head of the main stairway, containing an oil painting by Clark G. Voorhees of Graylock Mountain in the Berkshires.



NEW STEAMSHIP BERKSHIRE, FOR NIGHT SERVICE ON THE HUDSON RIVER BETWEEN NEW YORK AND ALBANY

New Pacific Coastwise Steamship Congress

The new twin-screw passenger and freight steamship *Congress* for the Pacific Coast Company, to be operated as part of their fleet by the Pacific Coast Steamship Company in the coastwise service between Seattle, Wash., and San Diego, Cal., was launched from the yards of the New York Shipbuilding Company, Camden, N. J., on May 17. The new vessel was christened by Miss Mary Phelps Jacob, a niece of Mrs. William M. Barnum, the wife of the president of the Pacific Coast Company.

The *Congress* is the largest vessel so far built for the sea coasting trade in the United States. She has been specially designed for this service by Mr. George W. Dickie, naval architect and marine engineer, San Francisco, Cal., who has

FIG. 1.—LAUNCH OF THE CONGRESS

personally superintended her construction in every detail. Her principal dimensions are as follows:

Length over all....................	441 feet.
Length between perpendiculars.....	425 feet.
Breadth, molded..................	54 feet 9 inches.
Depth, molded, to upper deck......	29 feet.
Depth of double bottom............	3 feet 10 inches.
Depth to main deck................	21 feet.
Main deck to upper deck...........	8 feet.
Upper deck to shelter deck.........	9 feet 6 inches.
Shelter deck to bridge deck.........	8 feet.
Bridge deck to boat deck...........	8 feet 4 inches.

The vessel, except where the design required special treatment, is constructed of steel in accordance with the A-1 20-year rating of the American Bureau of Shipping for vessels with three decks below a poop and forecastle and a shelter deck. She has a straight stem and elliptical stern, a flat keel and double bottom, subdivided by watertight floors and a longitudinal watertight vertical keel plate, fitted complete as water ballast and fresh-water tanks. The double bottom extends from the fore peak bulkhead on frame 12 to frame 144, at which point the inner bottom is raised to the top of the shaft alleys or lower deck, except between the alley bulkheads in the center of the ship forming No. 3 hold, where it is continued on the level of the engine foundations to the after peak bulkhead. The wing spaces under the watertight flat outboard of the shaft alley bulkheads are used for fresh-water tanks for galley, drinking and lavatory purposes; 160 tons of this water is carried. The double bottom extends to the upper turn of the bilge all fore and aft, forming a center line drainage, and is raised at the ends as required by the profile of the vessel.

The *Congress* has two pole masts, rigged as a fore and aft schooner with jib headed sails. There are four main hatches, the two after hatches being trunked through the three passenger decks. No. 2 hatch is trunked between the bridge and shelter decks. This hatch is made large so as to take the longest automobiles, there being room for twenty-four large cars on the upper deck. There are six side hatches on the main deck and two side hatches in No. 2 hold on the lower deck. There are two Otis elevators in No. 2½ hold. There are fourteen side cargo ports and four side passage ports. Four derrick booms are fitted to each mast, the two on the after side of the foremast of steel and capable of handling 15-ton weights. There are eight steam cargo winches and two steamboat winches. The cargo winches are fitted with machine-cut helical gears, made by the Andre Citroen Company, and are expected to run without noise.

The lower deck is of steel without covering and no camber. The main deck is of steel without covering except in the refrigerating spaces. At the after end, where third class passengers are berthed, this deck is worked flush and covered with linoleum. The upper deck is of steel and is worked flush throughout. In the staterooms this deck is covered with linoleum, also in the spaces aft of the kitchen. In the passages round the boiler enclosures the deck is covered with bitumastic cement. In the main dining saloon this deck is covered with dreadnought tiling, also in the pantry, while the kitchen is laid with special hard tiling. The shelter deck is of steel, and is worked flush throughout. In the staterooms this deck is covered with linoleum and the passages with dreadnought tiling. In the holds this deck is not covered. The bridge deck is framed with steel beams the same as the deck below, and is plated with steel outside of the deck enclosures and covered with 3-inch pine decking with teak margins. Inside the houses the covering is of 1¼-inch tongued and grooved pine covered with canvas.

Accommodations have been provided as follows: Deck department, 34; engineer's department, 28; steward's department, 83; miscellaneous, 8; total crew, 153. There are accommodations for 416 first class passengers, 120 second class passengers and 150 third class passengers.

The boat deck is entirely of wood, except certain steel framing under the boats, and is wholly covered with No. 2 canvas. Special steel structures are carried up to take the cargo winches for Nos. 3 and 4 holds, and the winches are set on heavy teak beds. The plank sheers and margin strakes round the hatches on this deck are all of teak.

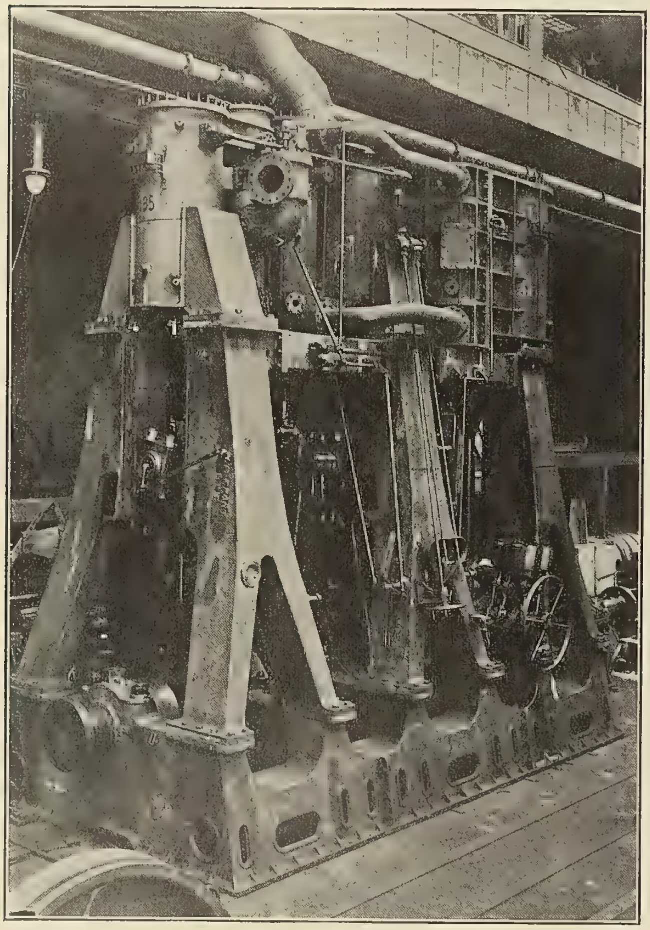


FIG. 2.—ONE OF THE MAIN ENGINES

On the boat deck are the following structures: On the forward end of the boat deck, which commences at frame 52, is a structure containing the captain's quarters and the first class smoking-room. The captain's quarters are finished in mahogany and extend the full width of the house, being 26 feet wide. These rooms are *en suite*, consisting of a bed-room, bath-room and reception room. The first class smoking-room is in Flemish oak, and is furnished with toilets and an enclosed bar. The sides of this house have been worked into alcoves with heavily upholstered settees. The flooring is covered with dreadnought tiling. The heating, here as elsewhere throughout the ship, is done by electricity. Two large heaters of the luminous type are worked into built-in fireplaces with mantels overhead.

Above the smoking-room is the navigating bridge, at the forward end of which is the wheel house. The bridge is entirely closed for a width of 26 feet, with a door on either side opening to the open wings, which extend 4 feet beyond the beam of the ship. Immediately aft of the enclosed bridge is the chart room, with officers' toilet and locker, and aft of the chart room the quarters for the officers, deck engineer and wireless operators.

Aft of the smoking-room, and extending between frames 78 and 85, is the forward deck lounge, forming an entrance for the grand stairway, which extends down through three decks and terminates in the main dining saloon. This room is finished in quartered oak and is carpeted. The stairway is mahogany and the treads covered with dreadnought tiling. Aft of this lounge, and also of the up-take enclosures and the special ventilating trunk from the galley, is the wireless operating room and office. Aft of the wireless room and the engine room hatch is the after deck lounge extending between frames 140 and 146, and forming an entrance for the after first class stairway. This room is in quartered oak. At the after end of the boat deck, between frames 160 and 196 and extending the full width of the deck, is the ball room. This enclosure is constructed without stanchions, giving a clear floor for dancing of 35 by 45 feet. Seats are built in around the sides and ends of this room to give the necessary stiffness to the walls.

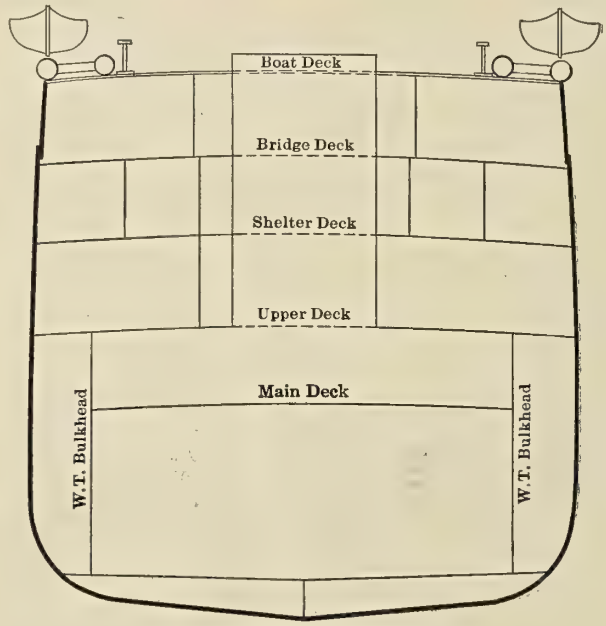


FIG. 3.—MIDSHIP SECTION

On the bridge and forecastle deck the house commences on frame 52 and extends to frame 178. Between frames 178 and 180 is a cross passage, completing the first class promenade on this deck, while aft of frame 180 and extending to frame 195 the house is continued to accommodate the public rooms for the second class passengers, who have their own promenade extending from frame 180 to the stern of the vessel.

The forward end of the house on this deck is occupied by the first class lounge, a handsome room finished in mahogany and 40 to 48 feet in size. The forward end of the house is of steel, and the sides are worked into bay windows, housing window seats. The windows are especially large, being 40 inches in depth. Six fireplaces are built into the finish of this room. Just abaft the lounge there are four suites of rooms with private baths and toilets, two in oak and two in mahogany. Aft of the *en suite* rooms are wide entrance halls from the deck outside, all the rooms opening into the inside corridors or lounges. The balance of this house is occupied by forty-four large first class staterooms and two rooms *en suite* with private toilets.

The public toilets on this deck, as on the deck below, are in the center of the ship between the two boiler hatches. A vent enclosure at the center line divides them into two sections.

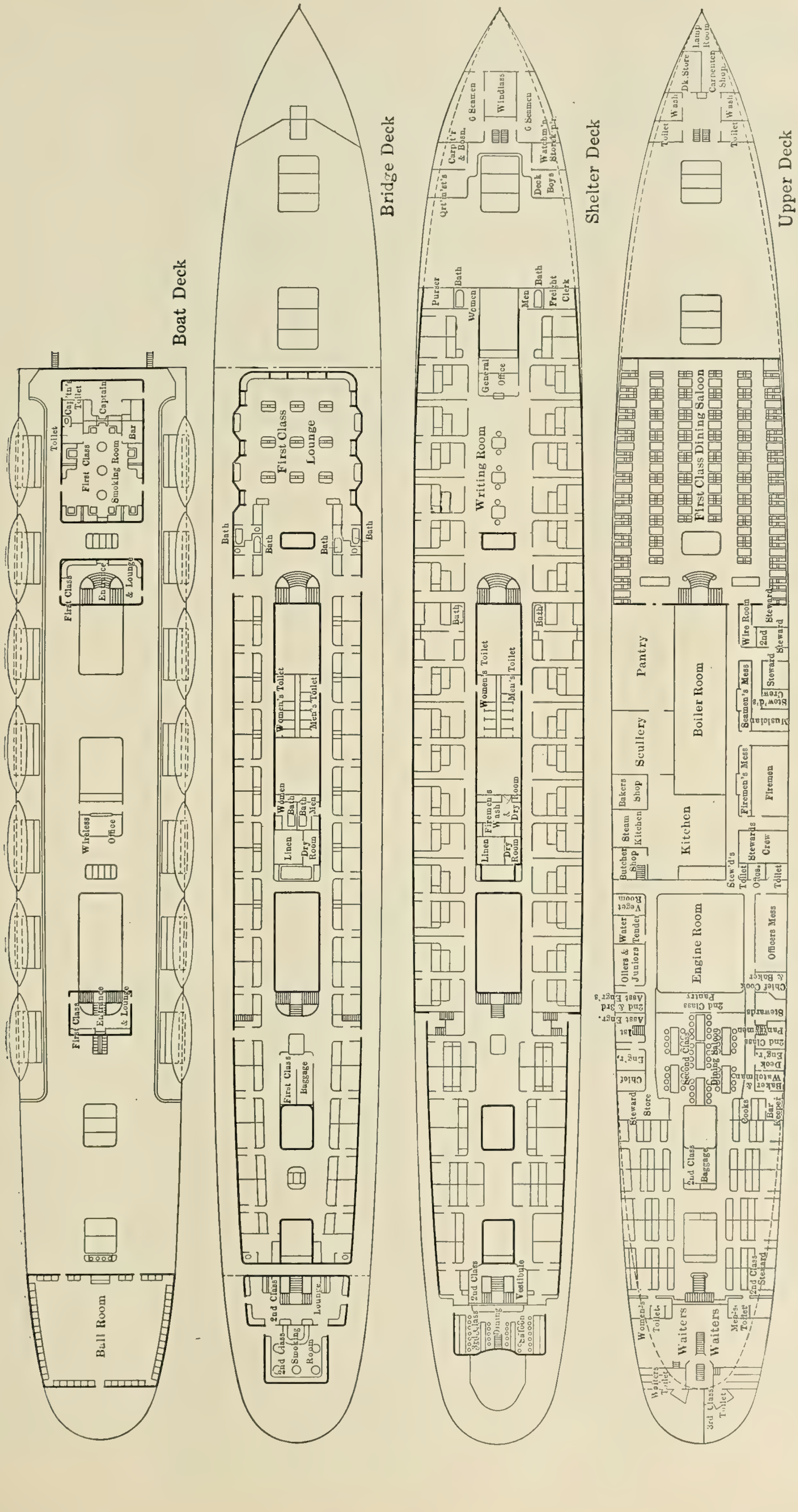


FIG. 4.—DECK PLANS OF THE CONGRESS

All the sanitary piping is run in this vent, which is carried up through the boat deck, where a large exhaust fan draws air from the passenger quarters in the 'midships part of the vessel through the toilets and then up into the open air above.

The second class deck house, aft of frame 180, is occupied by the second class smoking-room and the second class lounge, two comfortable and airy rooms. The lounge, which also serves as an entrance to the second class stairway, which terminates on the upper deck in the second class quarters, is finished in quartered oak and the smoking-room in Flemish oak.

The staterooms on this deck, as elsewhere throughout the ship, are fitted with large wardrobes and heated by electric radiators. A large parcel and hand baggage room is provided on this deck for the use of the first class passengers.

Forward on the shelter deck are the accommodations for petty officers and crew. The crew's quarters are large and the berths only two high. The passenger accommodations on this deck comprise eighty-four first class staterooms and ten *en suite* rooms. The ship's office is located immediately aft of No. 2 hatch enclosure, and is lighted by deck lights from the forecastle deck above. Aft of the office is a large lobby and writing room 20 by 30 feet in size. The sides of the vessel are cut away at frame 143, leaving a promenade for the third class passengers and crew extending from there to the stern. The three classes of passengers carried are thus effectively separated. Aft of frame 184 is the third class dining room and aft of this again the steering engine inclosure. This deck house is entirely of steel.

Forward on the upper deck are located, first, a lamp and paint locker, then a carpenter shop on the starboard side and deck storeroom on the port, then the wash rooms and toilets for the petty officers and crew. From frame 19 to frame 50 is cargo space, which is specially designed to carry automobiles, a large number of which are transported on the Western coast runs.

From frame 50 to frame 85 is the first class dining saloon. This room is entirely fitted with tables for four and accommodates 216. It is finished in mahogany to the lower turn of the cornice and the ceiling is finished white. Deep frames are fitted to compensate for the frames which have been cut in order to form large windows inside the ports. These window frames will be filled with prismatic glass, and the deep frames are extended inboard so as to form alcoves. The lighting fixtures here as elsewhere have been specially designed for the ship.

Aft of the dining room on the starboard side are the quarters of the steward and his first assistant, the wine room and mess rooms for the firemen, sailors, petty officers and licensed officers and berthing space for the firemen. On the port side are located the pantry, scullery, butcher shop, baker shop, steam kitchen and galley. In point of size and equipment the culinary arrangements on this vessel are among the most complete afloat. Aft of the kitchen are accommodations for the engineer's crew and the steward's crew.

The second class staterooms are located on this deck. Each room has four berths, two on a side, with 9 feet 6 inches head room. Here also is the second class pantry and the second class dining room, a handsome apartment finished in quartered oak with built-in sideboards. The extreme after end of this deck is taken up with the quarters for waiters and toilets for the second class passengers.

The third class passengers are berthed on the main deck below, and special movable bulkheads are provided in order to extend or curtail the third class accommodations as required.

The *Congress* is fitted with two sets of triple-expansion, surface-condensing engines, with high-pressure cylinders 28½ inches diameter, intermediate-pressure 46½ inches and low-pressure 78 inches diameter, the stroke being 54 inches. The indicated horsepower will be, collectively, 7,500, at about 86 revolutions, which is expected to drive the ship at a speed of 16½ knots. The propellers are three-bladed, turning outboard. The cylinders are independent of each other, to allow for freedom of expansion. Hard, close-grained cast iron liners are fitted to all cylinder casings. The valve chests are all in the fore and aft center line of the cylinders. The high-pressure and intermediate-pressure cylinders are fitted with piston valves, while the low-pressure valve is a double-ported balanced slide; each valve chest is fitted with the Lovekin improved assistant cylinder. The high-pressure piston is of cast iron and the intermediate-pressure and low-pressure pistons are of cast steel, and the depth of all pistons on the cylinder surface is 12 inches. The high-pressure piston is fitted with a solid plug ring, the surface being grooved for steam packing. The condensers are independent of the main engine frame, the total cooling surface being 12,700 square feet. The crankshafts are of the built-up type, and for each engine are in three interchangeable sections. The reversing gear is of the all-around type, it having advantages for warming up the engines without the danger of moving the ship. This is important where freight is handled up to the last minute.

The air pumps are of the Edwards type, diameter 30 inches, stroke 24 inches, and together with the feed and bilge pumps are operated through levers from the intermediate cross-head. The auxiliary feed pumps are of the Wier type, the water ends being of composition and extra heavy. There are special ballast pumps, fire, sanitary and bilge pumps, also special fresh water pumps for the distribution of fresh water, which is supplied under pressure to every stateroom. There is an automatic oil filtering system fitted. This system collects the oil that has gone through all bearings, pumps it to the filtering system and delivers it back clean to be used over again. There is an auxiliary condenser, feed-water heater and filter.

The electric light, heat and power plant consists of three direct-connected, 110-volt generating sets, each set having a capacity at normal load of 50 kilowatts, and will stand an overload of 25 percent for 25 minutes without undue heating. Each generator is directly connected to a vertical cross-compound engine. There are about 900 incandescent lamps, two 20-ampere searchlights, ten cargo reflectors, four cargo arc lights, three gangway lights, running lights, a complete electric heating system and sixteen motors for fans and kitchen machines.

There are ten single-ended marine boilers, 15 feet inside diameter and 11 feet 10 inches inside length, having in all thirty Morison suspension furnaces, all 48¼ inches outside diameter. The total heating surface of the main boilers is 22,116 square feet. Four main boilers are fitted in the after boiler compartment and six in the forward compartment. They are placed side by side on each side of the ship and arranged to fire athwartships. The two compartments are separated by a watertight bulkhead. There are also watertight longitudinal bulkheads at the backs of the boilers. These bulkheads are entirely independent of the skin of the ship, and are 5½ feet from the outer plating. The boilers are of the Scotch marine type, fitted for natural draft and constructed for a working pressure of 180 pounds. Oil fuel is to be used and the Dahl system has been installed. The oil bunkers will hold 7,500 barrels of oil, sufficient for a round trip from Seattle to San Diego and back.

Naval Architects' Meeting.—At the summer meeting of the Institution of Naval Architects, held in conjunction with the Institution of Engineers and Shipbuilders in Scotland, at Glasgow, June 23 to 27, the programme of papers presented was concerned chiefly with problems associated with merchant shipbuilding, and was for the most part of a practical nature. Problems associated with the design of merchant ships from the shipowners' and passengers' point of view, metallurgical problems, experimental work at the William Froude tank, and power transmission were the principal subjects discussed.

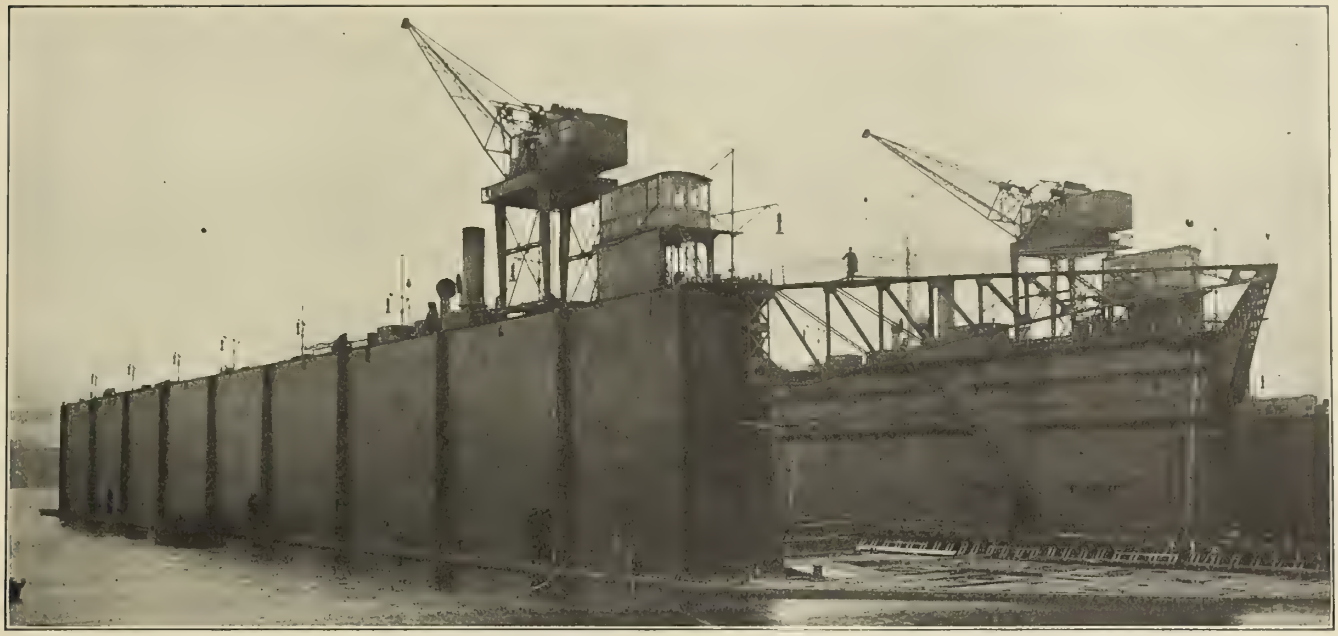


FIG. 1.—BOW VIEW OF 25,000-TON VULCAN DOCK

A German-Built 25,000-Ton Floating Dock

The 25,000-ton floating dock illustrated in the accompanying photographs has recently been constructed by the Vulcan Company, of Stettin, for service at their new shipbuilding yard at Hamburg. This dock is of the bolted sectional type, and was designed by Messrs. Clark & Standfield, naval architects and consulting engineers, of London. In the first place, the dock was originally designed to have four sections, but later the Vulcan Company decided to build only three of the four sections, and this had the effect of lowering the lifting capacity from 35,000 tons to 25,000 tons, and consequently the arrangement of the keel and bilge blocks is as shown in the photographs. The dock is replete with an extensive machinery equipment, and electrical power is generated from a central station on one of the dock sides. A 3-ton crane travels along the side of each wall, and in addition there are four stationary cranes, each ranging from 10 to 30 tons lifting capacity, located conveniently on the side walls.

The length of the dock over all is 525 feet and the width 140 feet, while the clear width inside the dock between the roller fenders is 102 feet. The height from the bottom of the pontoons to the top of the wings is 63 feet 6 inches, and the depth of the pontoons at the centerline is 20 feet. The length of each section is 165 feet, with the exception of the bow section, which is 196 feet long over all. As can be seen from the illustrations, valve houses are located at one end of each wing, while the boiler rooms are amidships.

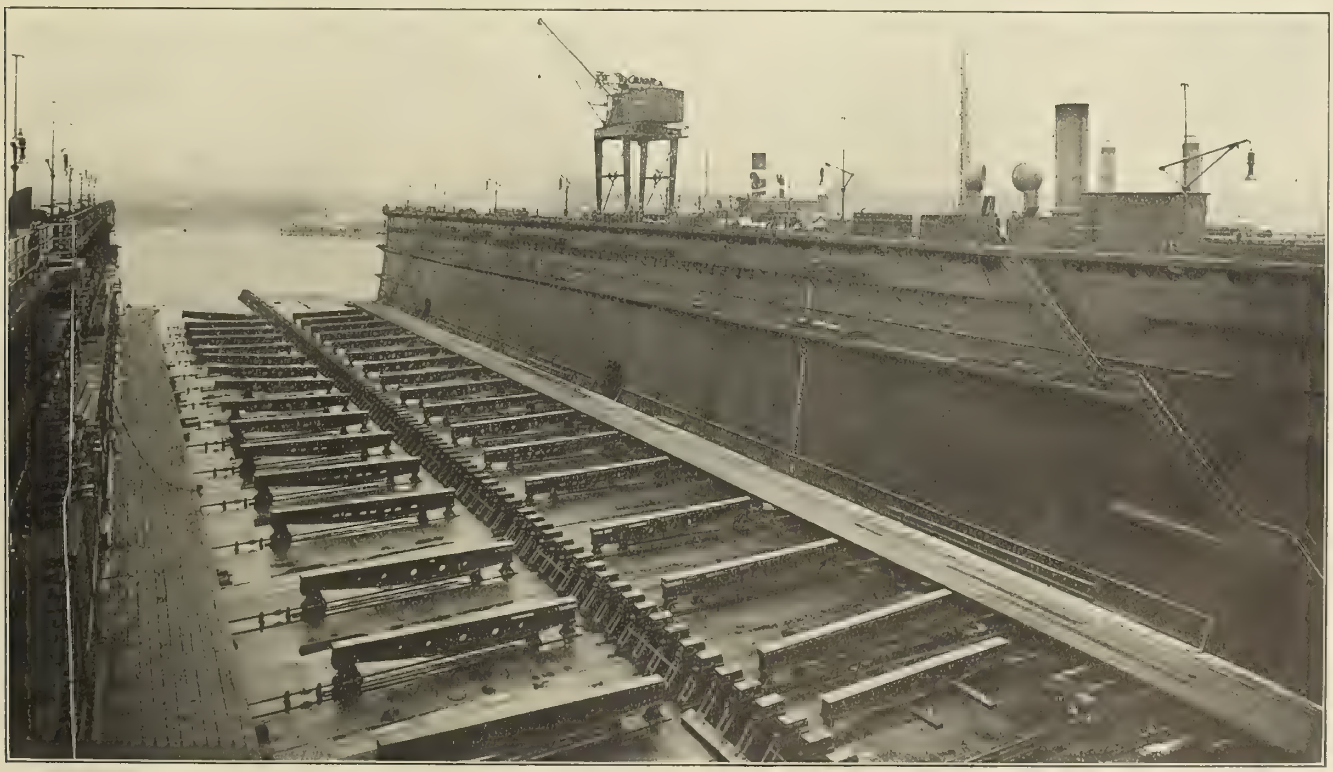


FIG. 2.—INTERIOR VIEW OF VULCAN DOCK, LOOKING AFT

French Battleship Jean Bart

The first French dreadnought, the *Jean Bart*, completed her official trials on May 15. This vessel was authorized by Parliament April 5, 1910; the order for her construction was placed with the Brest Dockyard Aug. 5, 1910; the keel was laid on Nov. 10, 1910, and she was launched in September, 1911. The main particulars are:

Length	541 feet 2 inches
Breadth	88 feet 8 inches
Draft, amidships	29 feet
Draft, astern	29 feet 7 inches
Brake horsepower	28,000
Speed	20 knots

The main armament consists of ten 12-inch guns located in five turrets. The elevation of the turrets above the load waterline is as follows: No. 1, 30 feet 7 inches; No. 2, 37 feet 1 inch; No. 3, 25 feet; No. 4, 28 feet 7 inches; No. 5, 21 feet 5 inches. The arc of fire available for each turret is as follows: Nos. 1 and 5, 135 degrees; Nos. 2 and 4, 140 degrees; No. 3, 180 degrees. The 12-inch guns are 59 feet long, weigh 55 tons each, and fire a shell weighing 970 pounds.

The secondary armament consists of twenty-two 5.5-inch guns; four 3-pounder guns and four 18-inch torpedo tubes, located two forward and two aft. Besides this armament the ship carries forty submarine mines of the Sauter-Harlé pattern.

The main armor belt extends for a length of 214 feet, and is 10 inches thick, reduced to 6.5 inches at the ends. The main belt is 13 feet 4 inches wide, and extends 7 feet 8 inches above the load waterline. The main citadel, which extends about 197 feet along the length of the vessel, is protected by 7-inch armor extending to a height of two decks, the ends of the citadel being inclosed with athwartship bulkheads of the same thickness. There are also two protective decks, the lower one, consisting of 2-inch plating on the flat and 3-inch plating on the slopes, extends 5 feet 7 inches below the load waterline. The upper protective deck is at the level of the upper edge of the main armor belt, and is made of 1 13/16-inch plating.

Steam is supplied by twenty-four watertube boilers of the Delaunay-Belleville type, having a total heating surface of 63,917 square feet and a total grate surface of 1,923 square feet. In these boilers the elements are made up of generating and reheating tubes. The generating tubes are 7 feet 11 inches long, 4 9/16 inches outside diameter, while the reheating tubes are 6 feet 7 inches long, 2¾ inches outside diameter. Each boiler has four furnaces, and they are arranged for using either coal or liquid fuel, the Delaunay-Belleville burner being used for liquid fuel.

There are thirteen coal bunkers having a total capacity of 2,700 tons and four compartments for liquid fuel, having a total capacity of 300 tons. Under ordinary circumstances only 900 tons of coal are to be carried. The steaming radius with full bunkers is 8,500 miles at 10 knots speed and 2,300 miles under full power.

Propulsion is by two sets of Parsons turbines, the starboard and port sets being entirely independent. High-pressure turbines drive the wing shafts and low-pressure turbines the inner shafts. The turbines are arranged in three independent engine rooms, the two high-pressure turbines being located each in a separate compartment, and the two low-pressure turbines in the center compartment. The condensers are also located in two independent compartments aft of the turbine rooms.

The first stages of both the ahead and astern high-pressure turbines are made up of wheels 11 feet 2 inches diameter, carrying four rows of buckets, while all other parts of the turbines, including the low-pressure turbine, are mounted on drums, and act on the reaction principle. The turbines have been designed for working at 300 revolutions per minute. Live steam may be delivered directly to the low-pressure turbines, and therefore the inner propellers may be set at work without interference with the wing propellers. The astern turbines have been designed for developing about 40 percent of the ahead power.

The condensers are of the usual type, with tubes 10 feet long and have a cooling surface of 16,038 square feet each.

The auxiliary machinery includes six electric generating sets of 200 kilowatts capacity operated by high-speed reciprocating engines.

Official Trials

Ten-Hour Full-Speed Trial, April 29

Number of boilers at work	24
Steam pressure	256 pounds
Average revolutions per minute	285
Mean speed on measured mile	21.16 knots
Mean speed for the 10 hours	21.09 knots
Mean speed per contract	20 knots
Fuel consumption per mile (per contract)	2,646 pounds
Fuel consumption per mile on trial	2,449 pounds

Three-Hour Full-Speed Trial with Forced Draft, May 5

Number of boilers under steam	24
Steam pressure	256 pounds
Revolutions per minute	305
Brake horsepower	42,000
Mean speed for three hours	22.04 knots
Best run on measured mile	22.63 knots
Fuel consumption per square foot of grate for 20 knots (per contract)	33 pounds
Fuel consumption per square foot of grate on trial	30 pounds
Fuel consumption on trial for 22.04 knots	33.3 pounds
Fuel consumption per horsepower, contract	1.874 pounds
Fuel consumption per horsepower, trial	1.698 pounds
Fuel consumption per mile run	3,168 pounds

Twenty-Four-Hour Endurance Trial, May 9 and 10

Number of boilers under steam	24
Number of revolutions per minute	240
Mean speed	18.57 knots
Consumption per mile, contract	1,830 pounds
Consumption per mile on trial	1,611 pounds

Cruising Trial, May 15

Number of boilers under steam	24
Mean speed	12.81 knots
Consumption per mile, contract	1,080 pounds
Consumption on trial	937 pounds

Obituary

E. S. Alexander, assistant to the general manager of the Newport News Shipbuilding & Dry Dock Company, died June 5 from an operation for appendicitis. Mr. Alexander represented the Newport News yard in Philadelphia.

Charles H. Cramp, for many years head of the shipbuilding firm of William Cramp & Sons' Ship & Engine Building Company, Philadelphia, died after a long illness in Philadelphia on June 6 at the age of 83 years. Mr. Cramp was one of the foremost American naval architects in his day, and did more to develop and advance the art of shipbuilding in the United States than probably any other man. He was the eldest son of William Cramp, founder of the Cramp shipyard, and entered his father's business as an apprentice at the age of 17. He was admitted to the firm in 1859, and remained at the head of the company until 1902, when he retired on account of advanced age. Throughout his life Mr. Cramp was actively engaged in the construction of a great many coastwise, transatlantic and naval vessels, both for the United States and foreign countries.

12,000-Ton Floating Dry Dock at Seattle

The Seattle Construction & Dry Dock Company, of Seattle, Wash., built during the last year and put into commission at their plant about February 1 of the current year a 12,000-ton floating dry dock of the "Rennie" type, the pontoons being of timber and the walls of steel. The general dimensions of the dock are as follows:

Length on keel blocks, 468 feet (to be increased later to 600 feet); width, 110 feet; width between walls, 90 feet; height of walls above deck of pontoons, 35 feet. There are six pontoons with the draft over the sill of 30 feet. The lifting power of the dock is 12,000 tons.

The six pontoons are identical in size and construction. Each pontoon contains eighteen trusses on 4-foot centers; the trusses are formed of arch members on top and longitudinal timber on the bottom, these two are connected by tie-rods and by struts and blocking between members. The deck of the pontoons upon which the walls are fitted is open to the walls, giving free communication for water between the walls and pontoons.

The center line bulkhead of the pontoons upon which the keel blocks rest, and which takes the weight of the vessel, is built up of heavy timbers and is watertight. On each side of the center are three bulkheads, one under the inboard side of the tower and two under the bilge blocks.

The connection between the steel towers and pontoons is made by heavy straps, which are bolted to the sides of the towers and to heavy steel straps on the sides of the pontoons. The connection on the inboard side of the towers is made in the same way.

The framing of the steel towers is cross-braced and stiffened by diagonals. The plating varies in thickness, and the towers are divided into six watertight compartments by bulkheads. A watertight steel flat extends fore and aft 9 feet below the top of the towers, which serves as a machinery deck where all the pump and capstan motors are located.

Any pontoon may be detached and self-docked at any time, thus making every part of the whole structure accessible for painting and repairing.

The keel blocks are placed 4 feet between centers, and are built up of 12-inch by 12-inch timbers. The two bottom timbers are of tallowwood and tapered, so that they can be driven out and the blocking removed under the keel of a vessel while on the dock. The bilge blocks are built up of fir timbers, and are so arranged that they can be altered easily to suit the shape of different vessels. The bilge blocks are pulled into position and removed by steel wire ropes running to hand winches on top of the towers.

When a vessel is in the dock, bow and stern lines are passed to the capstans on the towers, and the vessel is placed in position so that the keel is on the center line of the keel blocks. This position is indicated by centering chains extending across from tower to tower at each end of the vessel and having a plumb bob suspended at the center link.

The pumping plant consists essentially of six 18-inch vertical, motor-driven centrifugal pumps, having a combined capacity sufficient to dock a 12,000-ton vessel in two hours. The pumps are of the Kingsford Foundry & Machine Works, Oswego, N. Y., make, and are of the vertical, submerged volute type, each having a capacity of at least 500,000 gallons of water per hour against a static head varying from 4½ inches to 18 feet 5 inches. Each pump is driven by a 60-horsepower, 490 revolutions per minute, three-phase, 60-cycle, 440-volt constant speed vertical type induction motor of Westinghouse manufacture. All of the pumps and the operating house from which the entire dock is controlled are situated on one side of the dock, the operating house being located at one end of the tower on the upper or running deck.

One pump is located in each pontoon near the bottom of the pontoon and is mounted on a cast iron pedestal. The suction splits into two 12-inch branches, each one of which is provided with a "quick-opening" gate valve. Each branch serves one of the two watertight compartments of the pontoon. The twelve 12-inch gate valves are mechanically controlled, through rods and countershafts, by hand levers arranged in the operating house.

The motors are located on the machinery flat in the tower,

NEW SEATTLE FLOATING DRY DOCK OF 12,000 TONS CAPACITY each being arranged directly over its respective pump, to which it is connected by a vertical shaft. A flexible coupling is fitted above each pump, and for carrying the weight of shafting, etc., a suitable thrust washer and collar is provided in the pump. Each motor is independently controlled from the operating house by an oil-immersed auto starter with automatic overload and no voltage release attachments.

For lowering the dock, water is admitted through the pumps and 12-inch lines.

Trim Indicators

The athwartship trim of the dock can at once be read by a pendulum inclinometer fitted on the wall of the operating house.

For the fore and aft trim a horizontal pointer, fitted with a lever, is used, a graduated scale and adjustment being provided for one end.

The head of water in each compartment of the dock is recorded by an altitude gage located in the operators' house. From this gage a small pipe leads to a suitable place in the respective compartments and terminates in an inverted cup. A compressed air tank is provided, with a connection to each indicator pipe, so that all water can be forced out of the pipe, thus insuring an accurate reading of the head of water carried by the air pressure.

Capstans and Bollards

For warping ships into position in the dock, the running deck of each tower is provided with eight bollards and three capstans, the capstans being located one at each end of the tower and one in the center.

These capstans are each driven by a 25-horsepower, 440-volt, alternating-current, 720 revolutions per minute motor. The motors are located on the machinery deck below, each motor driving its capstan through gearing and a worm and wheel. The worm-wheel is fitted on the lower end of the vertical shaft, passing up through the running deck and fitted into the capstan at its upper end.

The capstans are of cast iron, and are designed so that they can be released from the vertical shaft for hand turning, six sockets being provided in each capstan. A cast iron base provided with groove and ball bearings carries the weight of capstan and shafting.

British Battle-Cruiser Tiger

The new British cruiser *Tiger* was laid down at the Clydebank shipyard early in 1912. The British Admiralty have, as usual, issued no particulars of the ship, but the broad features of the design which are given here may be taken as fairly accurate. The *Tiger* will be the largest, the fastest, the best protected and the most powerfully armed ship of the type in the world. With her great speed she could keep at such a distance as to render any attack upon her ineffective, while able still to do great destruction to the opponent. It is interesting to show in tabular form the progressive steps of the past seven years in battle cruisers for the British navy.

	Invincible.	*Lion.*	*Tiger.*
Date of Launch.	1907.	1910.	1913.
Length overall...	562 ft. 0 ins.	700 ft. 0 ins.	730 ft. 0 ins.
Length B. P.....	530 ft. 0 ins.	660 ft. 0 ins.	680 ft. 0 ins.
Breadth...........	78 ft. 0 ins.	86 ft. 6 ins.	90 ft. 6 ins.
Draft..............	26 ft. 0 ins.	27 ft. 6 ins.	28 ft. 6 ins.
Displacement.....	17,250 tons.	26,350 tons.	28,000 tons.
I. H. P...........	41,000	70,000	99,000
Speed.............	25 knots.	28 knots.	30 knots.
Armor belt........	7 ins.	9 ins.	11 ins.
Main battery.....	8 12-in. guns.	8 13.5-in. guns.	8 14-in. guns.
Secondary battery.	16 4-in. guns.	20 4.7-in. guns.	24 6-in. guns.
Torpedo tubes....	5 18-in.	5 21-in.	5 21-in.

The propelling machinery is of the Parsons steam turbine type, arranged for four screws. The turbines are designed to give 99,000 horsepower, and are placed in two watertight compartments, so that in each engine room there is one high-pressure ahead, and one high-pressure astern turbine mounted separately on the outer shaft, and a low-pressure ahead and astern turbine within one casing on the inner shaft. Four steel plate condensers are placed aft, together with the centrifugal pumps and other auxiliaries. The whole of the machinery arrangements are such as to preserve the independence of the port and starboard sets of machinery and to allow either set to be worked when all parts of the other are disabled. There are two air pumps and two circulating pumps for each pair of main condensers.

There are forty-two watertube boilers of the Yarrow type, working at a pressure of 235 pounds per square inch, and arranged for forced draft with closed stokeholds, and they are placed in seven boiler rooms. The coal bunker capacity is about 4,000 tons, and provision is also made for carrying 1,000 tons of fuel oil.

The ship has four propeller shafts, with one three-bladed, solid cast bronze propeller on each. She has two rudders of the underwater balanced type, with two sets of screw steering gear worked by one steam steering engine. The steering gear and rudder heads are placed under the protective deck. The ship's stern has a graceful curve and is made of cast steel, and it has no ram.

It was in the *Invincible* class that the all-big-gun principle was first adopted. They mounted eight 12-inch guns in four turrets, one forward and one aft, while the two on the broadside amidships were placed diagonally in order that they might be used on either broadside. In the *Tiger* this arrangement of guns has been discontinued, and her turrets are all arranged on the center line of the ship. The two turrets forward of the bridge are placed at different levels, so that the four guns may fire ahead and on each broadside. The 'midship pair will also fire on either broadside. The astern turret is on the upper deck level, and the superstructure has a long embrasure to give this pair of guns a wide arc of training before the beam.

The guns of the main battery are the new 14-inch pattern. The guns of the secondary battery are 6-inch quick-firing, and these are placed in the superstructure. The torpedo tubes are all under water. Torpedo defense nets are fitted all fore and aft, and they are suspended from sixteen booms on each side of the ship.

There are two lifeboats hung in davits, and motor launches and other small boats are stowed above the superstructure.

The *Tiger* is a powerful looking ship, with three vertical smokestacks and one mast. She is provided with the usual wireless telegraphy arrangements. The side armor is in three strakes, and extends to within about 60 feet of the stem and about 70 feet of the stern. For a length amidships two of the strakes are 11 inches thick, and the top strake is 7 inches, all tapering to 4 inches thick at the forward and after ends. The turrets are also of 11-inch armor.

The designed speed of the vessel is 30 knots, which will doubtless be greatly exceeded on the full power trial.

Marine Developments in Russia.—A Russian Imperial Vice-Consul informs International Marine Engineering of great developments taking place in Russia, including the following of a marine nature: The Admiralty will spend five hundred million rubles on new war vessels, to be built largely, if not entirely, in Russian shipyards. Two hunded million rubles are for enlarging and equipping with freight-handling apparatus Russian seaports. As Russian shipyards are overwhelmed with work, orders will probably be placed abroad for six powerful ice breakers, a fleet of tugboats, large and powerful dredges and other craft. Undoubtedly full information regarding any of these undertakings can be secured from the Russian Ambassador.

Change of Address.—Robert S. Haight, consulting engineer, ship and engine surveyor, is now located at 17 State street, New York City.

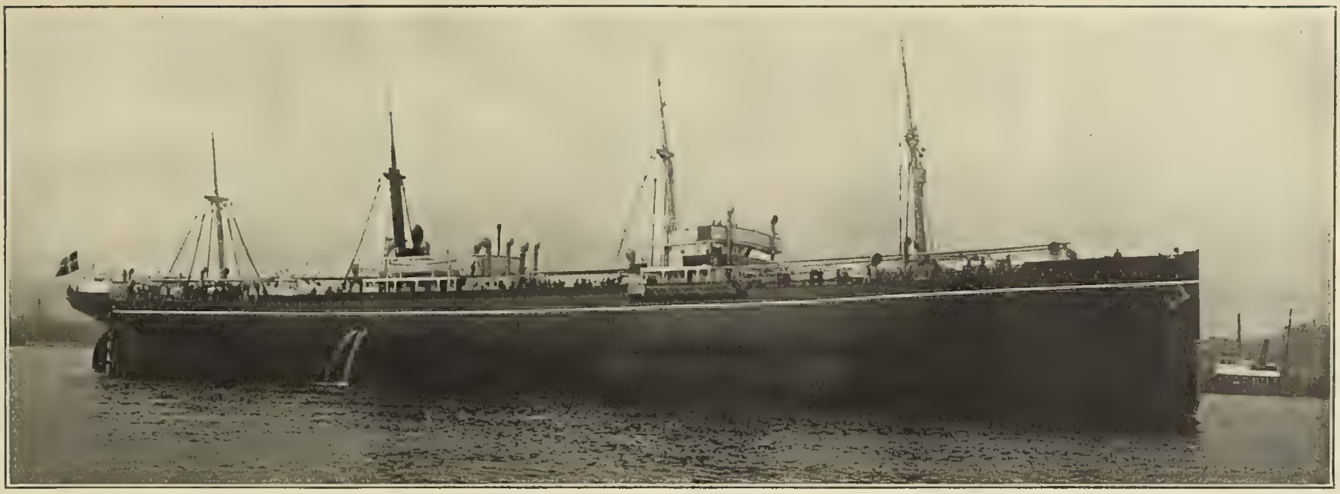


FIG. 1.—MOTOR SHIP SIAM, OF 13,200 TONS DISPLACEMENT

World's Two Largest Motor Ships

BY J. RENDELL WILSON

Until the Krupp 15,000-ton tank ship is launched the two new Burmeister & Wain motor ships *Siam* and *Annam* are the largest afloat, both being of 13,200 tons displacement. These ships are sister ships and conform to the main particulars published in the last issue. The general appearance of the ships and their engines is shown in the accompanying photographs.

The rapidity with which these builders are turning out these craft is truly remarkable when one considers the delay and postponed trials of certain other Diesel ships. As I write the new boat *Siam* has passed her trials successfully and is *en route* for Port Said, while by the time this appears in print her sister ship *Annam* will have commenced her maiden voyage. The latter makes the fifth large Diesel vessel that Burmeister & Wain have completed in under two years, the other three being the *Selandia, Christian X.* and *Suecia.* In addition they have eleven more on order, with an aggregate

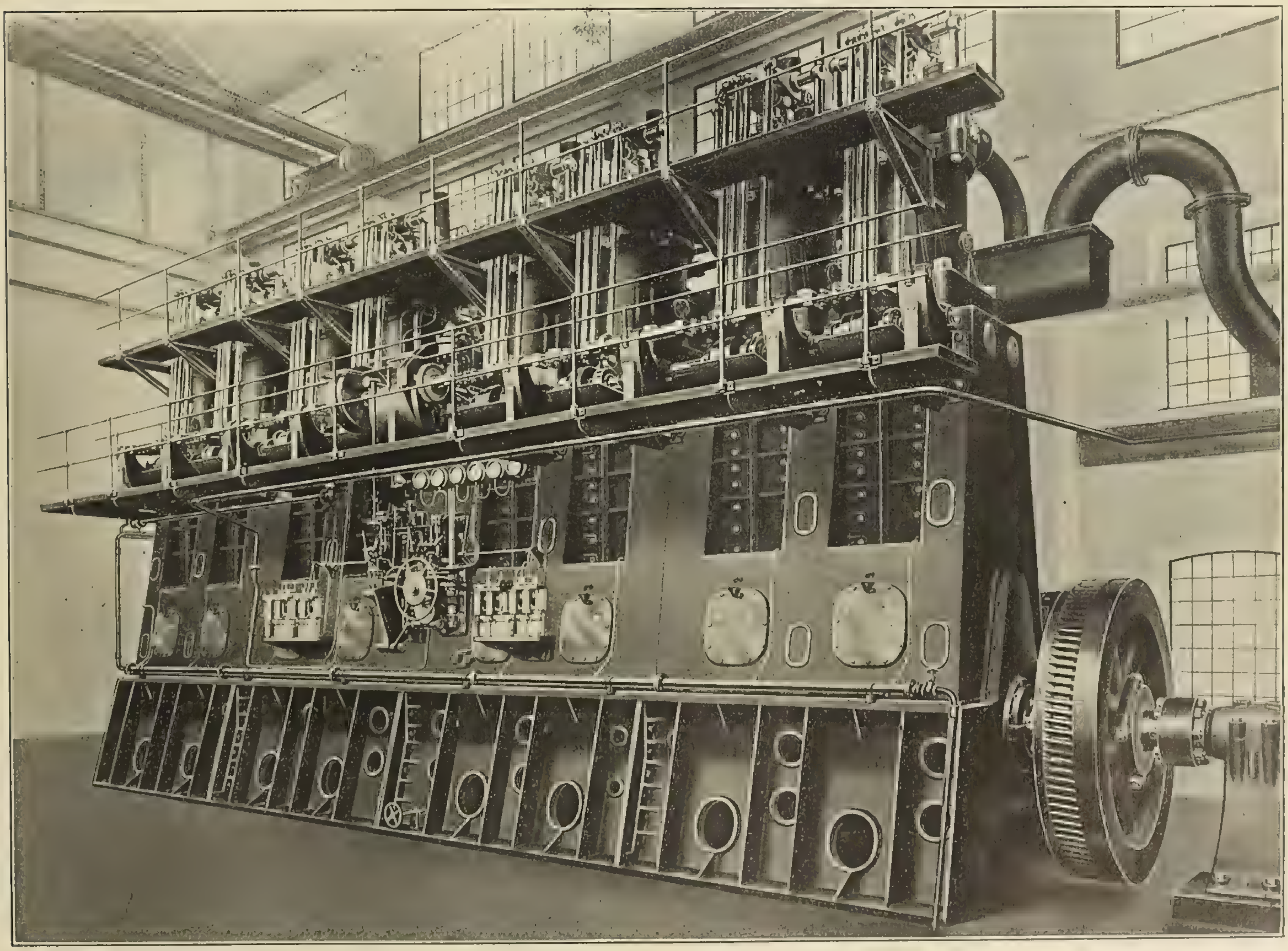


FIG. 2.—EIGHT-CYLINDER, BURMEISTER & WAIN DIESEL ENGINE FOR MOTOR SHIP SIAM

deadweight capacity of 83,500 tons and a horsepower of 30,700 indicated horsepower, one alone being of 4,000 indicated horsepower. It should be carefully noted that all these craft have or are having engines of the four-stroke type, which is a distinct shower bath for those who are firmly convinced that the two-stroke motor is the Diesel of the future, especially as the other four-stroke Diesel concerns, namely, the Werkspoor Company, the Kolommaer Company and Nobels can all show similar big order lists.

With regard to the other motor ships building by Burmeister & Wain, the complete list is as follows:

Vessel Yard No.	Owner	Length Feet	D. W. C. Tonnage	I. H. P.
286.	Nordsjjernan......	362	6,650	2,000
289.	"	"	"	"
290.	"	"	"	"
297.	"	"	"	"
298.	"	"	"	"
291.	Fornede Dampskib Selskab.........	405	7,250	2,700
293.	East Asiatic Co....	395	6,700	4,000
294.	"	410	9,200	3,500
295.	"	"	"	"
299.	"	"	"	"
300.	"	"	"	"

All are cargo vessels excepting yard No. 293, which will also carry passengers. This ship will have a speed of 13½ knots. With the two boats just described, and the three earlier motor ships *Selandia, Christian X.* and *Suecia,* the grand total power is 44,200 indicated horsepower, and the deadweight capacity is 124,250 tons, which is sufficient to give a good indication of the present stage of the industry. In any event the confidence of ship owners in the Diesel engine is well expressed.

Monthly Shipbuilding Returns.—The Bureau of Navigation reports 189 vessels of 39,913 gross tons built in the United States and officially numbered during the month of May. Eight of these, aggregating 21,283 gross tons, were steel steamships, 60 percent being built on the Atlantic coast and 37 percent on the Great Lakes.

A New Mail and Passenger Steamship for Newfoundland

BY F. C. COLEMAN

The steamship *Kyle,* shown in Figs. 1 and 2, is one of two steamships recently built by Messrs. Swan, Hunter & Wigham Richardson, Ltd., of the Neptune Shipyard, Walker-on-Tyne, for the Reid Newfoundland Company. The steamship *Lintrose,* delivered in March last, is now used in giving a service between the Reid Newfoundland Railway Company's terminus at Port Basque and Sydney, Cape Breton. The *Kyle* is intended for the Reid Newfoundland Company's coastal service between St. Johns and Cape Chudleigh, on the coast of Labrador, a service occupying a fortnight for the round trip. As this service is to be maintained all the year round, the *Kyle* has been specially designed and built to run through the heaviest ice which is met with during the winter months, and she is, besides, a finely modeled vessel, able to maintain

FIG. 1.—STEAMSHIP KYLE

a comparatively high rate of speed. Her accommodation for carrying passengers is of the most up-to-date and comfortable description, and well lighted, heated and ventilated.

The dimensions of the vessel are 220 feet length, 32 feet beam. Accommodations are provided for 68 first class and 141 second class passengers. The first class passengers are berthed amidships. They have a fine promenade deck, and in the house on that deck there is a comfortable smoking room, the walls being of oak, slightly fumed, with corresponding furniture upholstered in green leather. In the same house are the captain's room, the chief officer's room and the wheelhouse. Below this, on the upper deck, are the ladies' room and the first class dining saloon. The ladies' room has walls of sycamore, satinwood furniture upholstered in old rose moquette. Aft of the ladies' room is the entrance to the first class dining room. The dining saloon is a fine apartment, with walls and furniture of polished mahogany, the latter being upholstered with blue leather. This room is divided from the entrance by a very effective screen of polished mahogany, filled in with stained glass. The entrance hall and staircase connect the smoking room, dining saloon and first class staterooms, etc., and they are paneled in polished mahogany, while the floor is of india rubber tiling. The first class staterooms, situated on the main deck below the dining saloon, are fifteen in number, with accommodations for sixty-eight persons, one room being a ladies' room having ten berths. These are all enameled white, with mahogany furniture and upholstered with rose-colored moquette. The second class passengers are berthed in the after part of the vessel. On the main deck there is a compartment for 102 men, and aft of this another for 39 women. Above, on the upper deck, right aft, are two hospi-

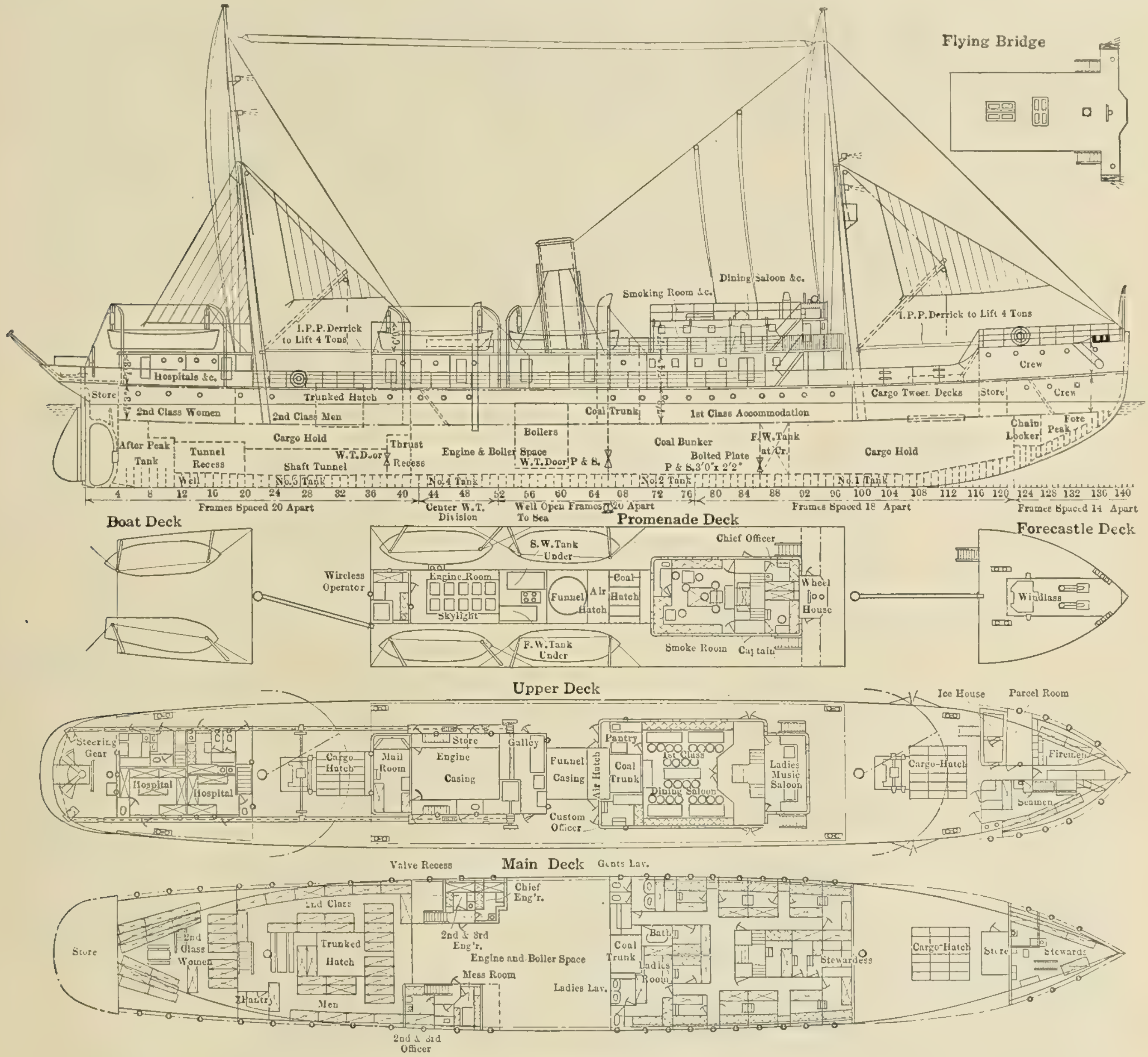


FIG. 2.—GENERAL ARRANGEMENT OF STEAMSHIP KYLE

tals, one for men, the other for women, together with rooms for doctors, baths, etc. The officers and engineers have rooms on the main deck at the sides of the engine casing, and the galley is placed on the upper deck forward of the engine casing, conveniently near the dining saloon.

The steamer is fitted with an installation of wireless telegraphy, a complete installation of electric light, including a searchlight, and an arrangement for steam heating suitable for the climate.

The vessel is propelled by a set of single-screw triple-expansion engines, having cylinders 18½ inches, 30½ inches and 50 inches diameter, by 36 inches stroke, supplied by steam from two single-ended boilers, 13 feet 9 inches diameter by 11 feet 6 inches in length, fitted with six corrugated furnaces, and working under Howden's system of forced draft at a pressure of 180 pounds per square inch. The main condenser is one of Weir's latest uniflux type.

Included among the auxiliary machinery in the engine room are Brown's steam and hydraulic reversing engines, a pair of Weir's feed pumps with direct contact feed heater, a centrifugal circulating pump, a feed-water filter, auxiliary condenser, two Alley & MacLellan's steam ash hoists, a MacNab indicator fitted on the bridge to indicate the movement of the main engines, and Brundrits circulators to the boilers, etc.

On the trial trip, which took place recently off Tynemouth, a speed of 13¾ knots was attained.

SPEED OF THE ARKANSAS.—On her standardization trials off Rockland, Me., May 31, the United States battleship *Arkansas*, constructed by the New York Shipbuilding Company, Camden, N. J., exceeded by nearly a knot the speed she made on her builders' acceptance trials. The fastest run on the Rockland course, May 31, was at a speed of 22.345 knots, while the fastest run on the builders' acceptance trials was at the rate of only 21.5 knots. The speed of the sister ship, *Wyoming*, on her acceptance trials was 21.223 knots.

Equipment for Unloading a Special Cargo at a German Steamship Pier

In a series of articles published in recent issues of the *Zeitschrift des Vereines deutscher Ingenieure,* by Prof. M. Buhle, of Dresden, dealing with new pneumatic suction grain elevators and other conveying and storage plants built by G. Luther, A. G., in Braunschweig, a description is given of an interesting equipment for unloading and conveying cargoes of nitrate of soda from steamships to specially designed storage houses. Nitrate of soda is brought to Germany from June to September, and must be stored until the following spring. In the place where this equipment was installed it was necessary to cross an arm of the river 200 feet wide to obtain storage space that would accommodate as much as 25,000 tons. The storehouse was constructed of reinforced concrete with four bays, each 200 feet long and 63 feet wide, in which the nitrate of soda is stored to a height of from 16 to 27 feet.

To unload the nitrate of soda, revolving dock cranes were used, delivering the cargo to the conveying plant. As the material could be handled only in bags, a conveyor line, extending the length of the pier back to the buildings and throughout the entire length of each shed, seemed best to fulfill the requirements. The electrically-driven trolleys are suspended from overhead tracks, carrying two platforms for bags and one operator's cage. It was thought best to have an operator on each trolley, as then its speed could be much higher, requiring fewer trolleys, giving greater safety of opera-

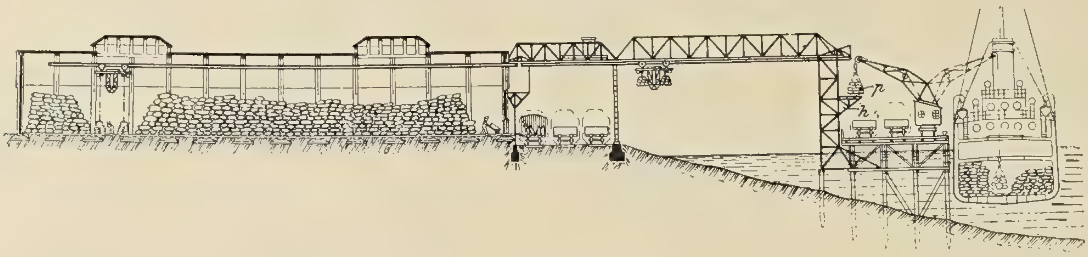


Fig. 1.—Section of Pier and Storehouses through B, Fig. 2

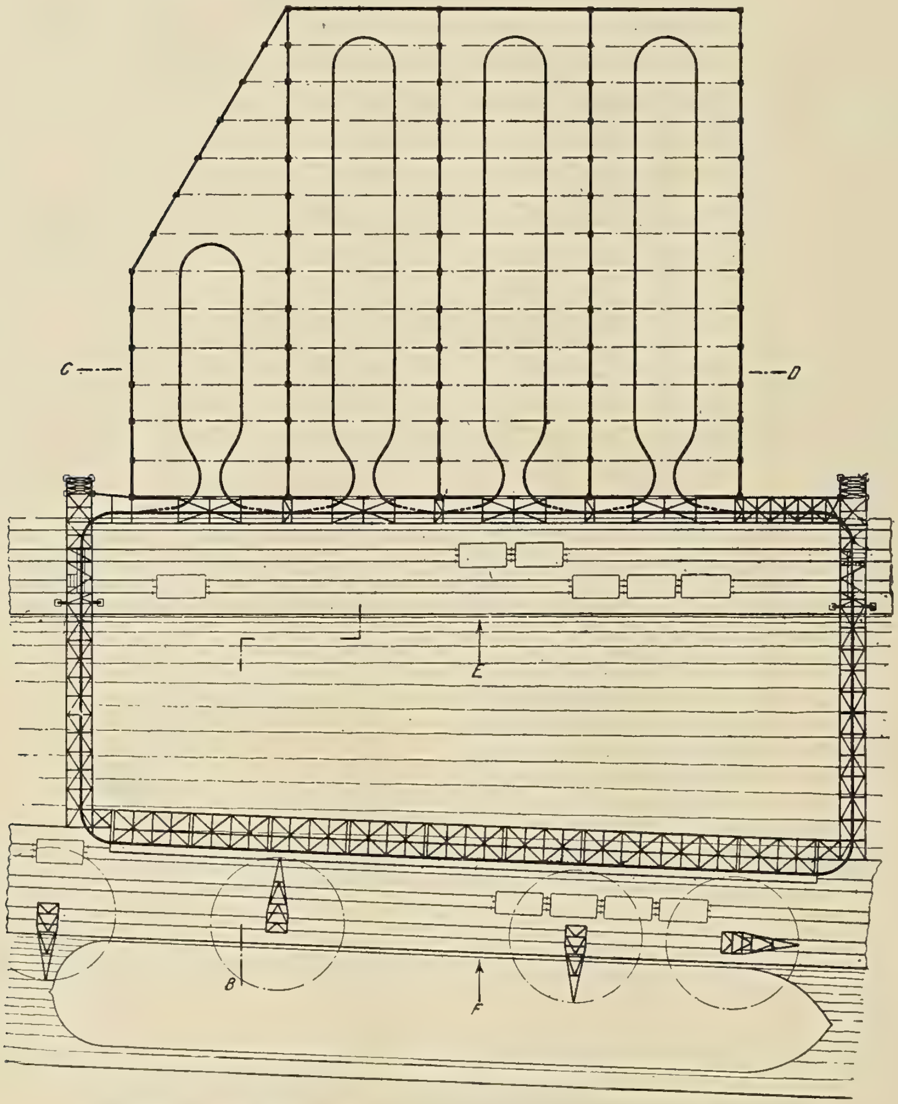


Fig. 2.—Plan of Pier and Storehouses, Showing Arrangement of Conveyors

tion and placing the material in the sheds much more readily.

To realize the full capacity of 600 bags per hour, the lifting motor and gear is in duplicate, thereby handling at each time two platforms with their loads. On board ship eleven bags are placed on one platform, which is lifted by the revolving dock cranes to an intermediate platform, where the trolleys take hold of two of them. In front of each shed are switches to direct the trolleys into any one bay. Before entering the sheds the bags are weighed on two automatic scales built directly into the trolley structure. At present two trolleys are in operation, which handle about 600 bags, or 60 tons per hour.

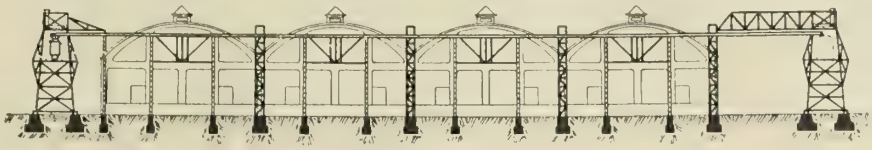


FIG. 3.—SECTION THROUGH E, FIG. 2

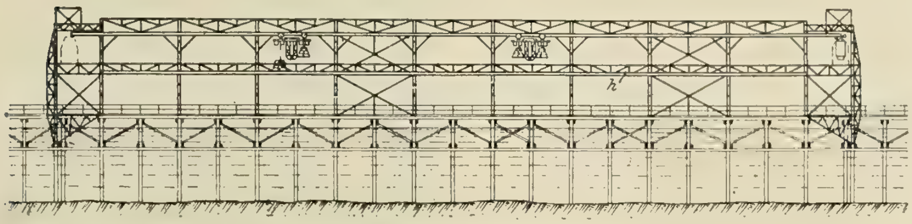


FIG. 4.—SECTION THROUGH F, FIG. 2

The motors are supplied with direct current of 200 volts, which is carried to them by a copper wire underneath the main supporting I-beam track. The trolleys are so constructed that a curvature of 13 feet 4 inches can be traversed without shock at a speed of 600 feet per minute. The winches on the trolleys are of the usual type, suited to overhead support with double drums, worm and wheel and single gearing drive. Each winch has its own motor. The switches of the track are hand-operated turntables, with special electrical block signals for indicating danger in case of an open switch.

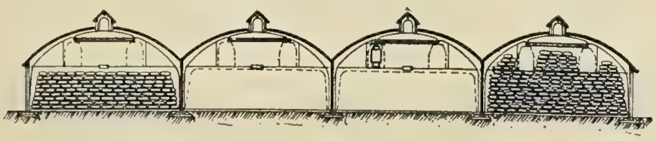


FIG. 5.—SECTION THROUGH C, D, FIG. 2

Motor Ship Fordonian

The Diesel-engined motor ship *Fordonian,* built by the Clyde Shipbuilding & Engineering Company, and fitted with a Carels Diesel engine, rated at 750 to 900 horsepower, recently made a trip from Port Glasgow to Sydney, a distance of 2,300 miles, in 17 days 21 hours. Very heavy seas were encountered on this voyage, but no difficulty was experienced with the machinery and no stops en route were necessary. The engine averaged 800 indicated horsepower on this trip, and the daily fuel consumption was 3½ tons.

Part of the ship's cargo was unloaded at Sydney and the rest at Montreal, where another cargo was shipped for Toronto, from which port the vessel will now enter upon regular service between Toronto, Kingston, Cleveland, Detroit, Port Arthur and the Western Lake shipping points. The *Fordonian* is owned by the Merchants' Mutual Line, and is under the direct supervision of Mr. Duguid, general superintendent of the line.

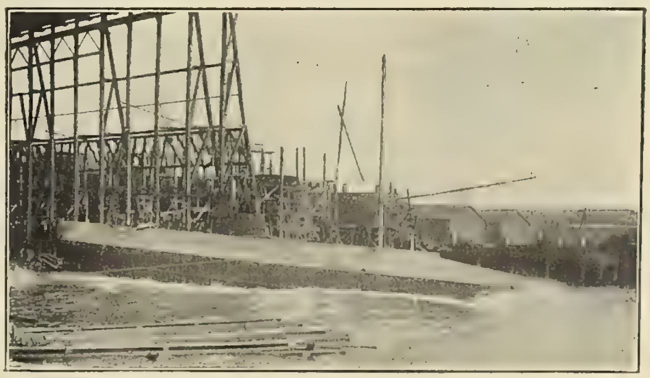
The vessel itself is 250 feet long, 42 feet 6 inches beam, 16 feet 10 inches molded depth to the main deck and 26 feet 6 inches to the awning deck. The deadweight carrying capacity is 3,300 tons on a draft of 16 feet 6 inches. As the draft in service will be restricted to 14 feet, the deadweight carrying capacity will be reduced to 2,200 tons.

The main propelling engine is a four-cylinder, two-stroke cycle, single-acting Carels engine with cylinders 18.1 inches diameter by 32.25 inches stroke. The propeller is 11 feet 9 inches diameter by 9 feet pitch.

Launch of Chilian Submarine

An event significant to this and South American nations, and particularly to the Pacific Coast, since it marks an epoch in the building of foreign warships on that coast, was the formal launching, under auspicious circumstances, of the Chilian submarine *Iquique* at the plant of the Seattle Construction & Dry Dock Company, Seattle, Wash., on June 3.

The *Iquique* was christened by Senora Maria Lorrain de von Schroeders, wife of Lieut. Edgar de von Schroeders, who is to be the first commander of this under-water fighter.



LAUNCH OF CHILIAN SUBMARINE AT SEATTLE

The vessel was built under the supervision of the Electric Boat Company, of which T. S. Bailey is Pacific Coast manager and G. H. Eggleton constructing engineer. A sister submarine for the Chilian Government, the *Antofagasta,* which is now building at the Seattle plant, will be launched in August. Both vessels will be delivered to the Chilian Government at Valparaiso, to which port she will be towed from Seattle under the direction of the Electric Boat Company. The crew for the *Iquique* was in Seattle at the time of the launching and was instructed in her operation during the builder's trial trips.

French Destroyer Magon

The destroyer *Magon* was launched on April 19 at the yards of the Ateliers & Chantiers de Bretagne, Nantes, France. This vessel belongs to the new class of 800-ton destroyers which have been specially designed as "fleet destroyers." The design of the hull was worked out by the technical staff at the shipyard with the assistance of Mr. Laubaeuf, the well-known naval architect, and shows a bold departure from the former types of destroyers. The stern of the boat, as shown by the photographs, is practically that of a racing motor boat. The design was worked out with the special intention of making the vessel capable of keeping up her speed in any kind of weather without undue stress.

The main particulars of the vessel are: Length over all, 272 feet 4 inches; beam, 27 feet; depth, 16 feet 5 inches; draft at stern, 10 feet; trial displacement, 787 tons; displacement with extra bunkers, 850 tons. The hull is built of Siemens-Martins steel, and is divided into eleven watertight compartments. The stem is of forged steel, and the stern post and shaft brackets, as well as the rudder, are all of cast steel. On each side of the center keelson there are five longitudinal girders or side keelsons. The sub-division of the boat is practically the same as in the *Fourche* and *Faulx,* described in previous issues of this journal; that is, the first compartment is the collision compartment, then come the chain lockers, stores and crew's quarters; aft of which are two independent boiler rooms, then two independent engine rooms, and finally the officers' and petty officers' quarters, ammunition rooms and storerooms.

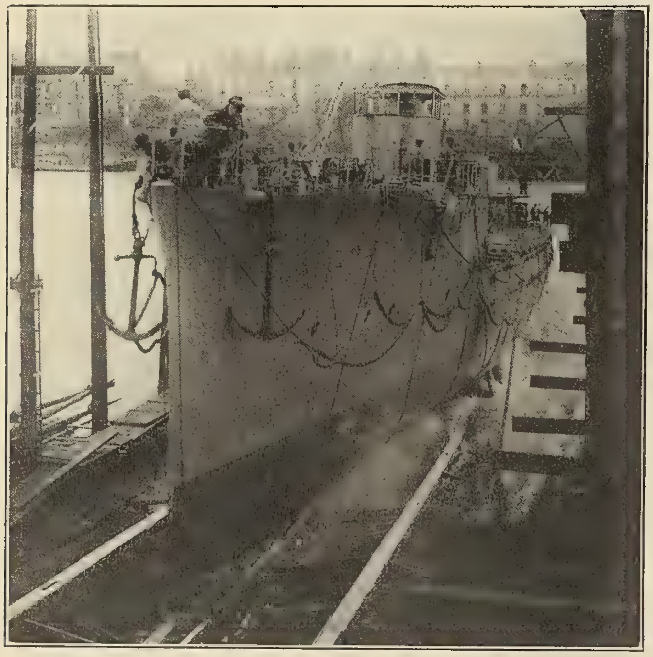


FIG. 1.—LAUNCH OF THE MAGON

Steam is supplied by four watertube boilers of the du Temple type at a pressure of 228 pounds per square inch. The boilers are fired with liquid fuel through du Temple burners, the maximum pressure of air in the stokehold not exceeding 6½ inches of water. The liquid fuel tanks have a total capacity of 1,300 cubic feet.

The main propelling machinery comprises four Rateau-Chantiers de Bretagne turbines (two for ahead and two for astern working), driving two bronze propellers, 7 feet 2 inches diameter and 7 feet 5 inches pitch. The turbines are arranged in two sets with two turbines in a single casing. Each set of turbines, comprising one ahead and one astern turbine, is therefore an independent set. The steam pressure at the entrance nozzles is 200 pounds per square inch, and at 650 revolutions per minute the designed brake-horsepower is 18,000, calculated to give the vessel a speed of 30 knots, although it is confidently expected that the contract speed will be considerably exceeded, giving a performance of something like 34 knots. Steam is exhausted from the turbines into two independent condensers, each of which has a cooling surface of 5,490 square feet.

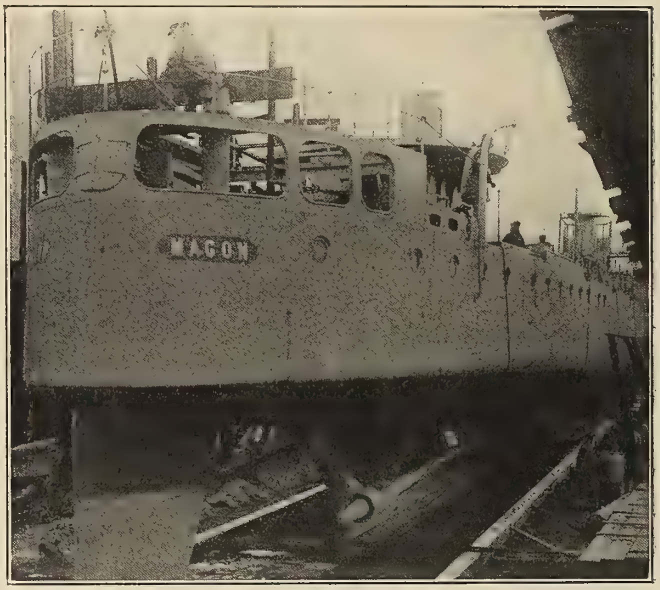


FIG. 2.—STERN OF MAGON

The electric plant on this boat consists of two dynamos of 13 kilowatts and 80 volts, operated by kerosene (paraffin) motors. The pumping arrangement consists of two powerful steam pumps, having a total capacity of 40 tons per hour.

The armament consists of four 65-millimeter quick-firing guns at the sides and two 4-inch guns fore-and-aft, besides four 18-inch torpedo tubes.

A New Type of Submarine Boat

The L. A. Submarine Boat Company, Long Beach, Cal., has recently completed for experimental and demonstration purposes a submarine boat built after designs patented by John M. Cage, general manager of the company. This test boat is 75 feet long, 7½ feet beam, with a depth of 9½ feet from the bottom of the keel to the top of its superstructure. The propelling machinery consists of two 90-horsepower Buffalo gasoline (petrol) engines, turning 900 revolutions per minute at full speed. The boat is also equipped with an air compressor and flasks for storing up 36,000 cubic feet of air at a pressure of 3,000 pounds.

This type of submarine differs from present types in three particulars. First, the gasoline (petrol) engines are used for motive power both while running on the surface and while running submerged. The expulsion of exhaust gases from the engines while running submerged is accomplished by mechanical means, thus giving the same amount of power available for propulsion under water as upon the surface and doing away with the electric storage battery system used in other types. Having the same power available for submerged running, it is claimed that a greater speed can be obtained while the boat is submerged than while on the surface, due to the absence of wave-making resistance while running submerged. Second, the propellers are placed at the forward end of the boat instead of at the stern. This principle, it is claimed, gives greater rudder control, in that it makes the point of application of the propelling force the fulcrum about which the ship is swung when taking a new course. Inci-

FIG. 1.—CAGE SUBMARINE BUILT FOR EXPERIMENTAL PURPOSES

dentally it enables the design of a boat with more reference to speed lines allowing a heavy fore body with full entrance and a light, fine after body with long run and broad horizontal rudders. The application of power in this boat, and the consequent control, it is claimed, overcomes the inherent tendency in the present type of submarine to "root" at a critical speed above which it is not safe for them to run even if they were powerful enough to do so. Third, by means of two tanks, one forward and one aft, which are open at the bottom to the sea and normally kept full of water, this submarine at all times has a large percentage of reserve buoyancy, as the normal displacement of the boat can be increased by blowing out the water from these tanks, effecting the same results as is often acquired by heavy drop keels. For submerging and trimming small ballast tanks are used.

Besides these three basic principles the builders of the boat claim to have accomplished considerable improvements in automatic equipment for trimming, depth control, ventilating, etc.

The experimental boat illustrated was given a thorough test in Long Beach harbor on March 26. The boat was submerged in 30 feet of water with the engines exhausting overboard against a back pressure of 12½ pounds, at the same time maintaining a vacuum on the engine exhaust of 23½ inches. The engines have also been run under water with a valve on the outboard exhaust closed down until the gage showed a back pressure of 150 pounds, corresponding to a depth of water of over 300 feet. At this pressure it is said the engines will run for thirty minutes, exhausting into a vacuum of 6 inches.

FIG. 2.—ENGINE ROOM OF CAGE SUBMARINE

Running on the surface a speed of 15 knots was obtained, and although the limits of the harbor where the tests were made prevented speed tests while submerged, yet it is estimated that when tried out in the open sea a speed of 19 knots can be obtained on the surface and about 19 1/3 knots submerged. Sufficient compressed air is carried on the boat to run the engines full speed submerged for four hours.

During the tests above referred to the boat was submerged for a depth of 18 feet under water, and it was demonstrated that the boat could be submerged either in a horizontal position or in an inclined position, either bow or stern first.

The Deflection Method of Calculating the Strength of Columns and Stanchions—I

A Fundamental Misconception in the Moncrief Formula, which has been Accepted as the Basis of the United States Navy Instructions for Determining the Scantling of Ship Columns

BY A. J. MURRAY

A free ended column supporting a load which rests exactly over its axis would not theoretically deflect, except upon the application of some lateral force. The condition would, however, be one of unstable equilibrium. The slightest disturbance would upset this state of unstable equilibrium, and the column deflect under the load.

The "deflection," or "eccentricity method," consists in assuming an eccentricity of loading, so that the column deflects initially by an amount depending upon the applied load, the

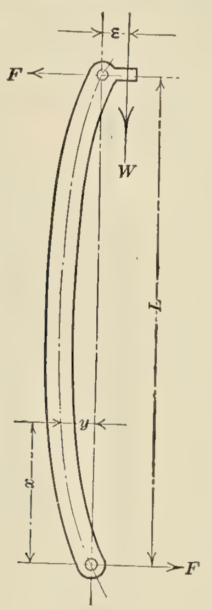


FIG. 1

eccentricity, and the material and proportions of the column. We might have regarded the eccentricity as due to a want of straightness in the column itself, but that would necessitate making an assumption as to the exact form of the supposedly bent column. Instead of this we have taken the column to be initially straight and the supports central, but supposed the load not placed exactly over the axis.

In Fig. 1 is shown diagrammatically a column loaded at a distance ϵ from the axis. The ends are guided in a vertical direction by means of frictionless pins, and the eccentricity ϵ is measured in the plane of bending, which is normal to the axis of the pins.

The Moncrief formula is based upon three assumptions:

(1) That the reactions of the pins at the top and bottom of the column may be neglected.

(2) That the form of the deflection curve is parabolic.

(3) That the neutral axis of any cross section passes through the center of gravity of that section.

The first of these assumptions we can regard only as a serious misconception, which invalidates any formulæ based thereon, as unless the load was applied through the pins, and these were not only eccentric, but by a miracle of chance lay in the same vertical line, there would be lateral reactions at the pins.

Let W = load on column.
L = length of column.

Since the column must be in equilibrium under the external forces coming upon it, there must be reactions at the top and

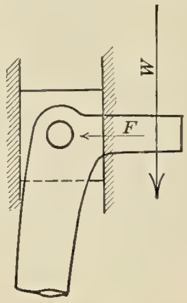


FIG. 2

bottom pins (Fig. 2), constituting a moment equal to the upsetting moment $W \times \epsilon$. Since there are no other horizontal forces these reactions must be equal and opposite.

Let T equal the magnitude of either reaction then for equilibrium

$$T \times L = W \times \epsilon$$

or

$$T = \frac{W\epsilon}{L} \qquad (1)$$

Now consider any section distant x from the foot of the column, and suppose the deflection from the vertical at that section is y. The bending moment at the section is then given by (Fig. 1)

$$M_x = W(\epsilon + y) - T(L - x).$$

Substituting T,

$$M_x = W(\epsilon + y) - \frac{W\epsilon}{L}(L - x).$$

$$= Wy + \frac{W\epsilon x}{L}.$$

The Moncrief formula overlooks this reaction entirely, and therefore expresses the bending moment at the section x, thus:

$$M_x = W(\epsilon + y).$$

Diagrammatically, the curves of bending moment would for the two cases be as shown in Fig. 3.

To dwell upon the two remaining assumptions is like raising an outcry because a dead man is minus a leg, but as they help to illustrate the subject we shall note them briefly.

The assumption that the curve of deflection is a parabola was arrived at by interpolating between the Sine curve derived by Euler for ideal columns and the circular form which fits the case of a constant bending moment throughout the length. This assumption involves an error of some 10 percent for normal ship columns. The Moncrief formula assumes that

$$M_x = W(\epsilon + y),$$

which may be written

$$-ET\frac{d^2y}{dx^2} = Wy + W\epsilon$$

a differential equation, of which the solution is

$$Y = A \text{ Cos. } nx + B \text{ Sine } nx - \epsilon,$$

where A and B are constants of integration, and

$$n = \sqrt{\frac{W}{EI}}.$$

From the terminal condition we have

$$A = \epsilon \; B = \frac{\epsilon\,(1 - \text{Cos. } n\,L)}{\text{Sin. } n\,L},$$

or

$$y = \epsilon \text{ Cos. } nx + \frac{\epsilon\,(1 - \text{Cos. } n\,L)}{\text{Sin. } n\,L} \text{ Sin. } nx - \epsilon$$

$$= \epsilon\left(\text{Cos. } nx + \frac{1 - \text{Cos. } n\,L}{\text{Sin. } n\,L} \text{ Sin } nx - 1\right)$$

The parabolic method would have given

$$Y = \frac{W L^2 \epsilon}{8EI - 5/6\,W L^2}\left(\frac{L^2 - 4x^2}{L^2}\right) + \epsilon$$

The third assumption turns out to be justifiable, though I find no reference to it either by Moncrief or by Mr. Anderson in his able explanation of Moncrief's deductions.

Moncrief assumed that the curve of deflection was parabolic, and given by

$$Y = \frac{\Delta\,(L^2 - 4x^2)}{L^2} + \epsilon$$

when Δ is the deflection at the middle of length. His bending equation we saw was

$$M_x = W y + W \epsilon$$

or substitute for Y

$$M_x = -E\,T \frac{d^2 y}{d x^2} = \frac{W \Delta\,(L^2 - 4x^2)}{L^2} + W \epsilon.$$

Integrating out we get

$$\Delta = \frac{W L^2 \epsilon}{8EI - 5/6\,W L^2}.$$

If p = direct compression stress, then the maximum fiber stress is on the compression side and at the middle section, and is given by

$$f = p + \text{bending stress.}$$

$$= p + \frac{y}{I}\,W\left(\epsilon + \frac{W L^2 \epsilon}{8EI - 5/6\,W L^2}\right)$$

giving Moncrief's formula:

$$\frac{L}{\gamma} = \sqrt{\frac{48\,E\left(\frac{f-p}{p} - \frac{y\epsilon}{\gamma^2}\right)}{5\,(f-p) + p\frac{y\epsilon}{\gamma^2}}}$$

Now, however, as we have both bending and direct stress at any section of the column, the neutral axis is not central, but at a distance h from the center, where $h = \frac{\gamma^2}{y}$ (γ being the radius of gyration of section), and the true bending equations are

$$\frac{f}{y+h} = \frac{E}{p+h} = \frac{M}{I},$$

so that

$$p = \frac{EI}{M_x} - \frac{\gamma^2}{y}.$$

For the parabolic curve assumed by Moncrief we should then have

$$-\frac{d^2 y}{dx^2} = \frac{1}{p} = \frac{W}{EI - W\gamma^2}(\Delta + \epsilon) - \frac{W}{EI - W\gamma^2}\,\frac{4\Delta}{L^2}\,x^2,$$

and integrating out we have

$$\Delta = \frac{\epsilon}{8\frac{\gamma^2}{L^2}\left(\frac{E}{p} - 1\right) - \frac{5}{6}},$$

instead of

$$\Delta = \frac{\epsilon}{8\frac{\gamma^2}{L^2}\,\frac{E}{p} - \frac{5}{6}},$$

as taken by Moncrief.

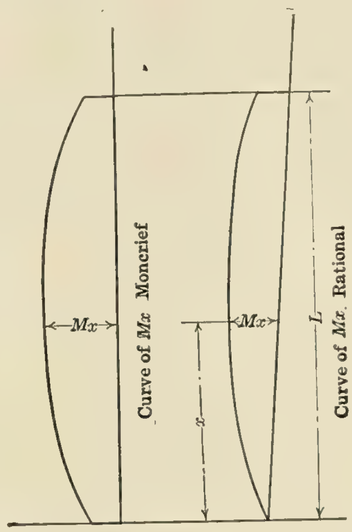


FIG. 3

Making this correction for the deflection, we get as a modified form of Moncrief's formula,*

$$\frac{L}{\gamma} = \sqrt{\frac{48\,(E-p)\left(\frac{f-p}{p} - \frac{y\epsilon}{\gamma^2}\right)}{5\,(f-p) + p\,\frac{\epsilon y}{\gamma^2}}}$$

the only difference being that E is replaced by $E - p$, which, as E is relatively large, makes practically no difference.

Finally, Moncrief claims that his formula agrees with experiment, and that the eccentricity factor $\frac{y\epsilon}{\gamma^2}$ may be regarded as a constant quantity.

Before leaving the subject of Moncrief's formula, it may be well to say that no censure of Mr. Anderson is intended, and that in telling us in the pages of this magazine just how he constructed the tables Mr. Anderson acted in the right spirit. In like spirit it is hoped he will accept and perhaps answer the above criticism.

* This method of making a correction for the shift of the neutral axis was given by Nevill, who applied it to Euler's expression, and we have only applied his analysis to the case in hand.

A Rational Formula for the Strength of Round=Ended Columns

We have shown that the true bending equation for an eccentrically loaded column is

$$M_x = W\,y + \frac{W\,\epsilon\,x}{L}. \qquad (1)$$

For small deflections we have

$$-E\,I\,\frac{d^2 y}{d\,x^2} = M_x = W\,y + \frac{W\,\epsilon\,x}{L}. \qquad (2)$$

The general solution of this equation is

$$y = A \text{ Cos. } nx + B \text{ Sin. } nx - \frac{\epsilon\,x}{L} \qquad (3)$$

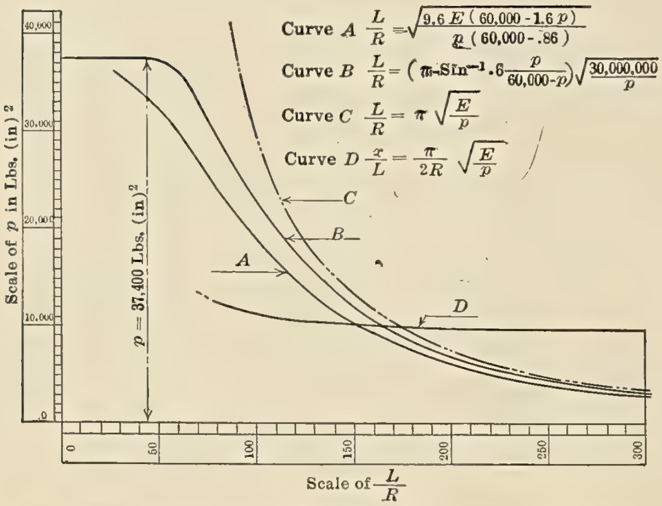


FIG. 4—Curve *A*, plotted from Moncrief formula; curve *B*, plotted from rational formula; curve *C*, plotted from Euler formula; curve *D*, height above foot to the most stressed section in terms of the length of column.

$$\text{where } n = \sqrt{\frac{W}{E\,I}}.$$

To find the value of the constants A and B we have

$$\text{when } x = 0,\ y = 0,\ \text{Cos. } nx = 1.$$
$$\therefore A = 0.$$
$$\text{Again, when } x = L,\ y = 0.$$
$$\therefore 0 = B,\ \text{Sin. } n\,L - \epsilon,$$
$$\text{or } B = \frac{\epsilon}{\text{Sin. } n\,L}.$$

$$\text{Hence } y = \frac{\epsilon}{\text{Sin. } n\,L} \text{ Sin. } nx - \frac{\epsilon\,x}{L}. \qquad (4)$$

Substituting this value of y in the bending equation (1) we obtain

$$M_x = W\,\epsilon \left(\frac{\text{Sin. } nx}{\text{Sin. } n\,L} \right) \qquad (5)$$

The only variable term is Sin. nx, and as the maximum value of Sin. nx is 1, we have

$$\text{Maximum bending moment} = \frac{W\,\epsilon}{\text{Sin. } n\,L}.$$

Taking the compression stress due to the direct load

$$= \frac{W}{\text{area of metal}} = p,$$

we have for the maximum fiber stress

$$f = p + \text{maximum bending stress.}$$
$$= p + \frac{y}{I}\,\frac{W\,\epsilon}{\text{Sin. } n\,L}.$$
$$= p + \frac{\epsilon\,y}{\gamma^2}\,\frac{p}{\text{Sin. } n\,L}.$$

where γ = radius of gyration of the section. Therefore,

$$\text{Sin. } n\,L = \frac{y\,\epsilon}{\gamma^2}\,\frac{p}{f - p}.$$

And since

$$n\,L = L\sqrt{\frac{W}{E\,I}} = L\sqrt{\frac{p}{E\,\gamma^2}} = \frac{L}{\gamma}\sqrt{\frac{p}{E}}$$

$$\therefore \text{ Sin. } \frac{L}{\gamma}\sqrt{\frac{p}{E}} = \frac{y\,\epsilon}{\gamma^2}\,\frac{p}{f - p}. \qquad (6)$$

This is a rational formua connecting $\frac{L}{\gamma}$ with p, and makes no assumption either regarding the form of the deflection curve or the omitting of the reaction at the ends.

If, in this equation, we put $\epsilon = 0$, then

$$\text{Sin. } \frac{L}{\gamma}\sqrt{\frac{p}{E}} = 0,$$

or

$$\frac{L}{\gamma}\sqrt{\frac{p}{E}} = \pi,$$

or

$$W = \frac{\pi^2\,E\,I}{L^2},$$

which is Euler's expression for the ideal column.

Again, for very long columns, the expression $\frac{p}{f - p}$ approaches zero, and in the limit we again have Euler's form, showing that the stress curve on a length ratio basis meets Euler's at infinity.

While no formula for the strength of columns which did not answer these tests could be strictly rational, it is evident that the Moncrief formula fails under both.

In Fig. 4 the curves of limiting loads are shown for mild steel, both for the Moncrief and for the above expression.

The value which Moncrief found for the eccentricity factor, $\frac{y\,\epsilon}{\gamma^2} = .6$, has been adopted in both cases for purposes of comparison. A table of the figured results is appended.

It may be noted here that the sine term entering into the above expression leads to no difficulty whatever, the labor being, in point of fact, much simplified.

$$\text{Putting } R = \frac{L}{\gamma}$$

$$\gamma = \frac{\epsilon\,y}{\gamma^2},$$

we have

$$\text{Sin. } R\sqrt{\frac{p}{E}} = \gamma\,\frac{p}{f - p},$$

or $$R = \left(\text{Sin.}^{-1}\,\gamma\,\frac{p}{f-p}\right)\sqrt{\frac{E}{p}}.$$

The general solution to an equation of the form Sin. $\theta = x$ is

$$\theta = S\,\pi - \text{Sin.}^{-1}\,x,$$

where S is any whole number. And in the above we must take

$$R = \left(\pi - \text{Sin.}^{-1}\,\gamma\,\frac{p}{f-p}\right)\sqrt{\frac{E}{p}}.$$

Example:

$\gamma = .6$, $f = 60{,}000$ pounds (inches)^2.

Suppose $p = 20{,}000$ pounds (inches)^2.

$E = 30{,}000{,}000$ pounds inches.

$$R = \left(\pi - \text{Sin.}^{-1}\,.6 \times \frac{60{,}000}{40{,}000}\right)\sqrt{\frac{30{,}000{,}000}{20{,}000}}$$

$$= (\pi - \text{Sin.}^{-1}\,.3)\,\frac{173.2}{4.47}$$

$$= (\pi - CM \text{ of } 17^\circ - 28')\,\frac{173.2}{4.47}$$

$$= (\pi - .3048)\,\frac{173.2}{4.47} = 110$$

As regards the point where the bending moment was a maximum we had

M_x is a maximum, where Sin. $nx = 1$, or where

$$nx = \frac{\pi}{2}, \text{ or } x = \frac{\pi}{2n}.$$

Taken in terms of the length of the column

$$\frac{x}{L} = \frac{\pi}{2nL} = \frac{\pi}{2R}\sqrt{\frac{p}{E}}.$$

The most stressed section is always above the middle of length.

An examination of the curve of ultimate stresses shows that there is a value of R greater than $R = 0$ ($R = 44.3$ for *M. S.*), at which the column is stressed to its limit by the direct action of the load alone, quite apart from the bending stress. For mild steel, assuming $\gamma = 6$, this limiting stress is 37,400 pounds, or about the elastic limit of the material.

Finally, as regards the validity of assuming $\frac{\epsilon y}{\gamma^2}$ = a constant quantity.

If we suppose γ to be a measure of the size of section, then we may take as a working basis $\epsilon \propto \gamma$, or $\epsilon = k\,\gamma$, when k is constant.

For a circular section, either solid or hollow (where the ratio of internal to external diameter is constant),

$$y = \gamma \times 4.$$

$$\text{So that } \frac{\epsilon y}{\gamma^2} = 4\,k = \text{constant.}$$

For a square section, either solid or hollow (where the ratio between the inside and outside dimensions is constant),

$$y = \gamma\,2\sqrt{3},$$

$$\text{So that } \frac{\epsilon y}{\gamma^2} = 2\sqrt{3}\,k = \text{constant.}$$

It follows that γ is constant for either a circular or square section, but that it is greater for the former, and hence a curve should be drawn for each case, the square section being the weaker of the two.

The above formula may thus be made to take into account not only the size but the form of cross section.

(*To be continued.*)

Cost of Handling Coal and Iron Ore on the Great Lakes

Some remarkable figures regarding the cost of handling coal and iron ore on the American Great Lakes were given by Honorable William C. Redfield, in his address at the annual banquet of the Society of Naval Architects and Marine Engineers. As the figures referred to a medium-sized vessel, the cost of handling these commodities is undoubtedly less in such large freighters as were described in our issue of September, these vessels having a deadweight carrying capacity at 20-foot draft of 13,200 tons.

The figures given referred to a single trip up the Lakes and return. This trip is given as an average of the sixteen round-trips made in the season of six to seven months that navigation is open on the Lakes.

The trip occupied fourteen days, and on the way up the Lakes the vessel carried 5,669 tons of coal from Toledo to Port Arthur at 30 cents (1/3) a ton net, and on the return trip carried 6,631 tons of iron ore from Superior to Ashtabula at 50 cents (2/1) net per ton. The total receipts for the trip were $5,000 (£1,040).

The direct expenses were about $2,500 (£520), and the principal items in these expenses were as follows: Handling the cargo, $786 (£164), or 31.4 percent total; crew's wages, $685 (£143), or 27.4 percent; fuel, $636 (£133), or 25.4 percent; groceries and provisions, $166 (£35), or 6.6 percent; machinery and boiler repairs and renewals, $93 (£19), or 3.7 percent, and harbor towing $52 (£10 10s.), or 2 percent.

Of these different items of expense there is no allowance for insurance, but the average premiums for such a round trip would be about $750 (£135). The amount allowed for depreciation would vary according to the policy of the owners, but in this particular case the policy is to wipe the whole investment off in twenty years on the ground that the boat is likely to be displaced in that time by an improved type. This would make the depreciation account average about $800 (£168) a round trip.

There would be other small charges against the vessel, such as the annual cost for repairs to hull and machinery, possible commissions on securing cargo, and taxes; but even deducting these it is estimated that the vessel would make at the very least in her sixteen round trips over $10,000 (£2,085).

SAFETY AT SEA.—With a view to obtaining specific information from experts as to the character of structural arrangements of ships which should be required by national and international regulations to secure their safety at sea, the Department of Commerce, Washington, D. C., has appointed a joint committee of officers from the Department of the Navy and the Department of Commerce to prepare a list of questions relating to the bulkhead subdivision of vessels and other structural features affecting the safety of ships at sea. The members of the committee are: Washington L. Capps, formerly chief constructor U. S. N.; David W. Taylor, naval constructor U. S. N.; George Uhler, supervising inspector general, Steamboat Inspection Service; E. T. Chamberlain, Commissioner of Navigation. Aided by James Donald, naval architect of Boston, who has been designated by a committee of shipbuilders on the Atlantic coast as their representative before the Department of Commerce in the preliminary investigation involved, the committee has issued to naval architects and marine engineers a comprehensive list of questions concerning the subject of safety at sea, and it is hoped that these will receive careful consideration so that present conditions may be improved in this respect.

Empirical Method of Screw Propeller Design*

BY PETER DOIG

The following examples, it is hoped, will make plain the steps in the necessary calculations with the diagrams. It may be noted that the wake factors used are taken straight from the curves of Fig. 1 without modification for cutaway sterns. If this had been done still closer agreements than found would have been shown between the actual and designed wheels.

Case 1: A single-screw cargo tramp. S. S. *Vespasian.* See International Marine Engineering, 1910, page 256.

Here block coefficient = .754; horsepower = 993.

Speed = 10.2 knots; revolutions = 70.

H_d = 993 × engine efficiency × power factor.
= 993 × .84 × .98. (See Table 1 and Fig. 2.)
= 816.

A preliminary approximation to diameter is made from a similar ship or other method for use in Fig. 2. A considerable divergence from the final diameter makes very little difference in the power factor.

$S_a = 10.2 \times .75 = 7.65$. (See Fig. 1, Curve *C*.)

$$\text{Then } C_r = \frac{70}{7.65^2}\sqrt{\frac{816}{7.65}} = 1.195 \times 10.32 = 12.33.$$

Entering Fig. 4 at this C_r value we find that at the line for locus of best wheels the pitch ratio is 1.03. To obtain the corresponding diameter Fig. 5 is then consulted, and at C_r value 12.33 and pitch ratio 1.03 a C_d value of 11.45 is found by interpolation between lines 11 and 12. Hence using the formula:

$$\text{Diameter} = D = \frac{C_d}{S_a}\sqrt{\frac{H_d}{S_a}},$$

$$\text{the diameter results} = \frac{11.45 \times 10.32}{7.65} = 15.45 \text{ feet.}$$

This gives the dimensions of the best three-bladed wheel:

Diameter = 15.45 feet.
Pitch = 15.45 × 1.03 = 15.9 feet.

From Table 2 a helicoidal disk-area-ratio of .36 is obtained; and from Fig. 8 the pitch correction at this area-ratio and the C_r value as above is found to be 1.005, corrected pitch resulting = 1.005 × 15.9 = 16.0 feet. Helicoidal area = 15.45^2 × .7854 × .36 = 67.5 square feet. This ship had a four-bladed propeller, so that the final solution is:

Diameter = 15.45 × .94 = 14.5 feet (14.0 feet).
Pitch = 16.0 feet (16.35 feet).
Helicoidal surface = 67.5 square feet (70 square feet).

The figures in parentheses are the dimensions of the actual wheel. This applies throughout the following examples:

Case 2: A twin-screw collier; three-bladed propellers. T. S. S. *Orion.* See *Journal American Society Naval Engineers,* 1912, page 1254.

Here block coefficient = .715; horsepower = 6943 (two shafts).

Speed = 14.47 knots; revolutions = 95.

$$H_d = \frac{6943}{2} \times .86 \times .98 = 2920. \text{ (Table 1, Fig. 2.)}$$

$S_a = 14.47 \times .825 = 11.95$. (Fig. 1, Curve *A*.)

$$C_r = \frac{95}{11.95^2}\sqrt{\frac{2920}{11.95}} = .664 \times 15.63 = 10.39.$$

On Fig. 4, pitch ratio of best wheel = 1.07; on Fig. 5, C_d corresponding = 12.7.

$$\text{Whence diameter} = \frac{12.7 \times 15.63}{11.95} = 16.6 \text{ feet (16.5 feet).}$$

Pitch = 16.6 × 1.07 = 17.8 feet (18.0 feet).

Helicoidal surface = 16.6^2 × .7854 × .375 = 81.5 square feet (82.5 square feet).

Disk-area-ratio from Table 2 being .375, with pitch correction negligible.

Case 3: A twin-screw battleship with reciprocating engines; three-bladed. United States battleship *Delaware. Journal American Society Naval Engineers,* 1911, page 672.

Here block coefficient = .600; horsepower = 26,500 (two shafts).

Speed = 21.4 knots; revolutions = 126.8.

$$H_d = \frac{26{,}500}{2} \times .88 \times .98 = 11{,}400. \text{ (Table 1, Fig. 2.)}$$

$S_a = 21.4 \times .87 = 18.62$. (Fig. 1, Curve *A*.)

$$C_r = \frac{126.8}{18.62^2}\sqrt{\frac{11{,}400}{18.62}} = .366 \times 24.75 = 9.06.$$

On Fig. 4, pitch ratio of best wheel = 1.11; on Fig. 5, C_d corresponding = 13.65.

$$\text{Whence diameter} = \frac{13.65 \times 24.75}{18.62} = 18.15 \text{ feet (18.25 feet).}$$

Pitch = 18.15 × 1.11 = 20.1 feet (19.75 feet).

Helicoidal surface = 18.15^2 × .7854 × .40 = 104 square feet (106 square feet).

Disk-area-ratio from Table 2 being .40; with no pitch correction (Fig. 8).

Case 4: A twin-screw scout cruiser; reciprocating engines; three-bladed screws. United States cruiser *Birmingham. Journal American Society Naval Engineers,* 1908, page 726.

Here block coefficient = .40; horsepower = 15,476 (two shafts).

Speed = 24.33 knots; revolutions = 191.6.

$$H_d = \frac{15{,}476}{2} \times .90 \times .975 = 6790. \text{ (Table 1, Fig. 2.)}$$

$S_a = 24.33 \times .94 = 22.9$. (Fig. 1, Curve *A*.)

$$C_r = \frac{191.6}{22.9^2}\sqrt{\frac{6790}{22.9}} = .365 \times 17.22 = 6.29.$$

On Fig. 4, pitch ratio of best wheel = 1.24; on Fig. 5, C_d corresponding = 16.6.

$$\text{Whence diameter} = \frac{16.6 \times 17.22}{22.9} = 12.48 \text{ feet (12.5 feet).}$$

Pitch = 12.48 × 1.24 = 15.47 feet (15.25 feet).

Helicoidal surface = 12.48^2 × .7854 × .40 = 49 square feet (49 square feet).

Disk-area-ratio from Table 2 being .40; with no pitch correction (Fig. 8).

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* Concluded from the June issue. For the illustrations mentioned in this article the reader is referred to pages 242, 243 and 244 of the June issue.

EXAMPLES IN DESIGN OF TURBINE-DRIVEN WHEELS

Case 5: Triple-screw fast passenger steamer reaction turbines; three-bladed screws. *Camden. Journal American Society Naval Engineers,* 1907, page 723.

Center Screw: Block coefficient = .540; speed = 19.0 knots. Brake horsepower = 1550; revolutions = 543.

$H_d = 1550 \times .98 \times .94 = 1427$. (Table 1, Fig. 2.)

$S_a = 19.0 \times .79 = 15.0$. (Fig. 1, Curve *E*.)

$$C_r = \frac{543}{15^2}\sqrt{\frac{1427}{15}} = 2.41 \times 9.75 = 23.5.$$

From Fig. 6 C_d = 7.85; from Fig. 5 at C_r 23.5 and C_d 7.85, pitch ratio = .90.

Whence diameter $= \dfrac{7.85 \times 9.75}{15.0} = 5.10$ feet, and pitch for .40 disk-area-ratio (helicoidal) = 5.10 × .90 = 4.59 feet.

From Fig. 7 at 543 revolutions the projected disk-area-ratio = .50.

Helicoidal disk-area-ratio corresponding = .50 (.80 + .90 × .33) = .55.

From Fig. 8 at .55 disk-area-ratio and C_r = 23.5, pitch correction = .975.

The propeller indicated is

Diameter = 5.10 feet (5.0 feet).

Pitch 4.59 × .975 = 4.48 feet (4.5 feet).

Helicoidal surface $5.1^2 \times .7854 \times .55 = 11.3$ square feet (10 square feet).

Side Screws: Horsepower = 1490 (one shaft); revolutions = 561.

$H_d = 1490 \times .98 \times .94 = 1372$. (Table 1, Fig. 2.)

$S_a = 19.0 \times .885 = 16.8$. (Fig. 1, Curve *D*.)

$$C_r = \frac{561}{16.8^2}\sqrt{\frac{1372}{16.8}} = 1.985 \times 9.03 = 17.93.$$

From Fig. 6 C_d = 9.4; from Fig. 5 at C_r 17.93 and C_d 9.4, pitch ratio = .90, whence diameter $= \dfrac{9.4 \times 9.03}{16.8} = 5.05$ feet, and pitch for .40 disk-area-ratio (helicoidal) = 5.05 × .90 = 4.54 feet.

The helicoidal disk-area-ratio and pitch correction result as in the center screw, the propeller indicated being:

Diameter = 5.05 feet (5.0 feet).

Pitch = 4.54 × .975 = 4.44 feet (4.5 feet).

Helicoidal surface $= 5.05^2 \times .7854 \times .55 = 11.0$ square feet (10 square feet).

Case 6: Twin-screw high-speed scout cruiser; impulse turbines; three-bladed screws. U. S. S. *Salem*. See *Journal American Society Naval Engineers,* 1908, page 991.

Here block coefficient = .400; horsepower = 19,200 (two shafts.

Speed = 25.95 knots; revolutions = 378.3.

$$H_d = \frac{19{,}200}{2} \times .98 \times .97 = 9120. \text{ (Table 1, Fig. 2.)}$$

$S_a = 25.95 \times .94 = 24.4$. (Fig. 1, Curve *A*.)

$$C_r = \frac{378.3}{24.4^2}\sqrt{\frac{9120}{24.4}} = .636 \times 19.35 = 12.3.$$

From Fig. 6 C_d = 12.3; from Fig. 5 at C_r 12.3 and C_d = 12.3, pitch ratio = .89.

Whence diameter $= \dfrac{12.3 \times 19.35}{24.4} = 9.75$ feet, and pitch for .40 helicoidal disk-area-ratio = 9.75 × .89 = 8.67 feet.

From Fig. 7 at 378 revolutions the projected area ratio = .53. Helicoidal ratio corresponding = .53 (.80 + .89 × .33) = .58.

From Fig. 8 at .58 disk-area-ratio and C_r = 12.3, pitch correction = .98. The solution is, therefore,

Diameter = 9.75 feet (9.5 feet).

Pitch = 8.67 × .98 = 8.48 feet (8.7 feet).

Helicoidal surface $= 9.75^2 \times .7854 \times .58 = 43.2$ square feet (43.7 square feet).

Case 7: Quadruple-screw battleship; reaction turbines; three-bladed screws. U. S. B. S. *Utah*. See *Journal American Society Naval Engineers,* 1911, page 670.

Outer Shafts: Block coefficient = .584; horsepower = 6770 (one shaft).

Speed = 21.04 knots; revolutions = 327.3.

$H_d = 6770 \times .98 \times .96 = 6360$. (Table 1, Fig. 2.)

$S_a = 21.04 \times .84 = 17.65$. (Fig. 1, Curve *F*.)

$$C_r = \frac{327.3}{17.65^2}\sqrt{\frac{6360}{17.65}} = 1.05 \times 18.98 = 19.95.$$

From Fig. 6 C_d = 8.7; from Fig. 5 at C_r = 19.95 and C_d = 8.7, pitch ratio = .90.

Whence diameter $= \dfrac{8.7 \times 18.98}{17.65} = 9.35$ feet, and pitch for .40 helicoidal disk-area-ratio = 9.35 × .90 = 8.42 feet.

From Fig. 7 at 327 revolutions projected disk-area-ratio = .53. Helicoidal disk-area-ratio corresponding = (.80 + 90 × .33) .53 = .58.

From Fig. 8 at .58 disk-area-ratio and C_r = 19.95, pitch correction = .975. The propeller indicated is

Diameter = 9.35 feet (9.17 feet).

Pitch = 8.42 × .975 = 8.20 feet (8.5 feet).

Helicoidal surface $= 9.35^2 \times .7854 \times .58 = 40$ square feet (41 square feet).

Inner Shafts: Abbreviating the above procedure:

$H_d = 6740 \times .98 \times .96 = 6330$ (Table 1, Fig. 2); $S_a = 21.04 \times .81 = 17.05$. (Fig. 1, Curve *G*.)

$$C_r = \frac{319.8}{17.05^2}\sqrt{\frac{6330}{17.05}} = 1.10 \times 19.26 = 21.2;$$ C_d corresponding = 8.4. (Fig. 6.)

$$\text{Diameter} = \frac{8.4 \times 19.26}{17.05} = 9.48 \text{ feet.}$$

Pitch ratio at .40 disk-area-ratio = .90; pitch = 9.48 × .90 = 8.53 feet.

Pitch correction at .58 disk-area-ratio = .975.

Wheel indicated:

Diameter = 9.48 feet (9.17 feet).

Pitch = 8.53 × .975 = 8.32 feet (8.5 feet).

Helicoidal surface = 41 square feet (41 square feet).

Case 8: Twin-screw battleship; impulse turbines; three-bladed screws. U. S. B. S. *North Dakota*. See *Journal American Society Naval Engineers,* 1911, page 678.

Here block coefficient = .60; horsepower, 15,650 (one shaft).

Speed = 21.66; revolutions, 280.4.

Abbreviating the procedure:

$H_d = 15{,}650 \times .98 \times .975 = 14{,}950$; $S_a = 21.66 \times .88 = 19.05$.

$$C_r = \frac{280.4}{19.05^2}\sqrt{\frac{14{,}950}{19.05}} = .773 \times 28.0 = 21.65;$$ C_d corresponding = 8.85. (Fig. 6.)

$$\text{Diameter} = \frac{8.85 \times 28.0}{19.05} = 13.0 \text{ feet.}$$

Pitch ratio at .40 disk-area-ratio = .80; pitch = 13.0 × .80 = 10.4 feet.

Projected disk-area-ratio from Fig. 7 = .50.

Helicoidal ratio corresponding = .50 (.80 + .80 × 33) = .53.

Pitch correction = .98. (Fig. 8.)

Wheel indicated:

Diameter = 13.0 feet (13.0 feet).

Pitch = 10.4 × .98 = 10.2 feet (10.3 feet).

Helicoidal surface 70½ square feet (71.3 square feet).

Case 9: A quadruple-screw high-speed scout cruiser; reaction turbines; three-bladed propellers. U. S. S. *Chester*. See *Journal American Society Naval Engineers*, 1911, page 678.

Here block coefficient = .40; speed = 25.9 knots.

Outer shafts:

$$H_d = 5680 \times .98 \times .955 = 5320;\ S_a = 25.9 \times .90 = 23.3.$$

$$C_r = \frac{604.4}{23.3^2}\sqrt{\frac{5320}{23.3}} = 1.113 \times 15.1 = 16.8;\ C_d$$

corresponding = 9.85. (Fig. 8.)

$$\text{Diameter} = \frac{9.85 \times 15.1}{23.3} = 6.38 \text{ feet.}$$

Pitch ratio at .40 disk-area-ratio = .91; pitch = 6.38 × .91 = 5.8 feet.

Projected area ratio from Fig. 7 = .60.

Helicoidal ratio corresponding = .60 (.80 + .91 × .33) = .66.

Pitch correction = .975. (Fig. 8.)

Wheel indicated:

Diameter = 6.38 feet (6.0 feet).

Pitch = 5.8 × .975 = 5.65 feet (6.0 feet).

Helicoidal surface = 21 square feet (19 square feet).

Inner Shafts:

$$H_d = 6300 \times .98 \times .955 = 5900;\ S_a = 25.9 \times .85 = 22.0.$$

$$C_r = \frac{602.5}{22^2}\sqrt{\frac{5900}{22}} = 1.244 \times 16.4 = 20.4;\ C_d$$

corresponding = 8.6. (Fig. 6.)

$$\text{Diameter} = \frac{8.6 \times 16.4}{22} = 6.41 \text{ feet.}$$

Pitch ratio at .40 disk-area-ratio = .90; pitch = 6.41 × .90 = 5.77 feet.

Projected area ratio from Fig. 7 = .60; helicoidal ratio = .66.

Pitch correction .97. (Fig. 8.)

Wheel indicated:

Diameter = 6.41 feet (6.0 feet).

Pitch = 5.77 × .97 = 5.60 feet (6.0 feet).

Helicoidal surface = 21 square feet (19 square feet).

Case 10: A twin-screw destroyer; impulse turbines; three-bladed screws. U. S. T. B. D. *Warrington*. See *Journal American Society Naval Engineers*, 1911, page 968.

Here horsepower = 12,846 (two shafts); revolutions = 641.

Speed = 30.12 knots.

Here wake factor = 1.03 (see page 243, June issue); S_a = 30.12 × 1.03 = 31.02.

$$H_d = \frac{12{,}846}{2} \times .98 \times .96 = 6040.$$

$$C_r = \frac{641}{31.02^2}\sqrt{\frac{6040}{31.02}} = .665 \times 13.94 = 9.27;\ C_d$$

corresponding = 15.1. (Fig. 6.)

Pitch ratio at .40 helicoidal disk-area-ratio = .90. (Fig. 5.)

$$\text{Whence diameter} = \frac{15.1 \times 13.94}{31.02} = 6.78 \text{ feet, and pitch} =$$

6.78 × .90 = 6.1 feet.

From Fig. 7 projected disk-area-ratio = .57.

Helicoidal disk-area-ratio corresponding = .57 (.80 + .90 × .33 = .63.

Pitch correction from Fig. 8 = .985.

The propeller indicated is, therefore,

Diameter = 6.78 feet (6.67 feet).

Pitch = 6.1 × .985 = 6.0 feet (6.17 feet).

Helicoidal surface = 22½ feet (23 square feet).

Case 11: A triple-screw destroyer; reaction turbines; three-bladed screws. U. S. T. B. D. *Flusser*. See *Journal American Society Naval Engineers*, 1910, page 32. Going through the design in the foregoing order we get:

Wing Screws:

$$H_d = 3923 \times .98 \times .945 = 3635;\ S_a = 30.41 \times 1.04 = 31.65. \text{ (See } ante.\text{)}$$

$$C_r = \frac{806}{31.65^2}\sqrt{\frac{3635}{31.65}} = .805 \times 10.69 = 8.61;\ C_d \text{ corresponding} = 15.4.$$

Pitch ratio at .40 helicoidal disk-area-ratio = .96.

$$\text{Whence diameter} = \frac{15.4 \times 10.69}{31.65} = 5.2 \text{ feet; pitch} = 5.2 \times$$

.96 = 5.00 feet.

From Fig. 7 projected disk-area-ratio = .64; helicoidal ratio corresponding = .72.

Pitch correction = .983. Propeller indicated:

Diameter = 5.20 feet (5.25 feet).

Pitch = 5.00 × .983 = 4.91 feet (4.83 feet).

Helicoidal surface = 5.2^2 × .7854 × .72 = 15.3 square feet (15 square feet).

Center Screw: Here "*W*" = 1.02; S_a = 30.41 × 1.02 = 31.05.

Revolutions and power are such that

$$C_r = \frac{790}{31.05^2}\sqrt{\frac{3425}{31.05}} = .819 \times 10.5 = 8.6.$$

The C_d corresponding is 15.4; both these values being the same as in the wing screws. This gives the same solution as the wing screws.

Examples in Small Craft

Case 12: Single-screw steam launch; two-bladed propeller. (See Durand, Resistance and Propulsion of Ships, page 422.)

Here horsepower = 39.3; revolutions = 196.5.

Speed = 8.5 knots; length = 54.8 feet.

$$\frac{\text{speed}}{\sqrt{\text{length}}} = \frac{8.5}{\sqrt{54.8}} = 1.15;\ \text{from Fig. 3, "}W\text{"} = .81.$$

$$S_a = 8.5 \times .81 = 6.89;\ H_d = 39.3 \times .90 \times .94 = 33.3.$$ (Table 1, Fig. 2.) (Preliminary estimate of diameter being 4 to 5 feet.)

$$C_r = \frac{196.5}{6.89^2}\sqrt{\frac{33.3}{6.89}} = 4.13 \times 2.20 = 9.10.$$

Pitch ratio of best three-bladed wheel of .40 disk-area-ratio = 1.12. (Fig. 4.)

C_d corresponding (Fig. 5) = 13.7.

$$\text{Diameter} = \frac{13.7 \times 2.20}{6.89} = 4.38 \text{ feet.}$$

The best three-bladed wheel for the revolutions and power would therefore have (adopting .40 area ratio from Table 2):

Diameter, 4.38 feet; pitch, 4.38 × 1.12 = 4.91 feet; helicoidal surface = 6 square feet.

The equivalent two-bladed wheel is:

Diameter = 4.38 × 1.04 = 4.56 feet (4.33 feet).

Pitch = 4.91 feet (5.14 feet).

Helicoidal surface = 6 square feet (6.13 square feet).

Case 13: Racing displacement motor boat; single screw; three-bladed. *Dixie II.* See *Transactions Society Naval Architects and Marine Engineers,* 1905, page 368.

Here B. H. P. of gasoline (petrol) engine = 170 (see below); revolutions = 1120.

Speed = 26 knots; length = 40 feet.

$$\frac{\text{speed}}{\sqrt{\text{length}}} = \frac{26}{\sqrt{40}} = 4.1; \text{ from Fig. 3, ``}W\text{''} = .92.$$

$S_a = 26 \times .92 = 23.9$; $H_d = 170 \times .95 \times .86 = 139$. (Table 1, Fig. 2.) (Preliminary estimate of diameter being about 2 feet.)

$$C_r = \frac{1120}{23.9^2}\sqrt{\frac{139}{23.9}} = 1.955 \times 2.41 = 4.70.$$

Pitch ratio of best three-bladed wheel of .40 area ratio = 1.38. (Fig. 4.)

C_d corresponding (Fig. 5) = 19.0.

$$\text{Diameter} = \frac{19.0 \times 2.41}{23.9} = 1.92 \text{ feet.}$$

From Table 2 a disk-area-ratio of .55 is obtained.

Pitch correction = .993. (Fig. 8.)

Whence the screw indicated is:

Diameter = 1.92 feet (1.95 feet).

Pitch = 1.92 × 1.38 × .993 = 2.63 feet (2.67 feet).

Helicoidal surface = $1.92^2 \times .7854 \times .55$ = 1.6 square feet (1.64 square feet).

The rated power of this engine was 150, but the usual formula for power of gasoline engines gives 170 as above.

The Compensating Quadrant Crane

BY HARRY W. BROADY*

The new type of crane which was described briefly on page 509 of the December, 1911, issue of International Marine Engineering, has aroused considerable interest, and inquiries have been made for further information on this subject. It is the object of this paper to answer these inquiries, and to give, both from the technical and from the practical side, a more or less detailed description of this new crane.

The crane is an invention of Capt. A. P. Lundin and Axel Welin, and since the first time mentioned several cranes of this type have been built, thus making it possible to give a more complete description of the construction and operation.

The compensating quadrant crane is a derrick crane; that is, a crane with a jib or girder that can be raised or lowered. The jib is securely fastened at its lower end to two quadrants. In smaller cranes the jib and the quadrant are cast in one piece. The circumferential part of the quadrant has both a finished surface rolling in a slot and teeth that engage in a rack. The slot and the rack are cast in the bottom plate. A frame work is built up on the bottom plate, consisting of a frame forward and one aft, with a connecting top piece. The actuating screw or screws work in bearings in this top part, which part also holds the bearing at the top of the post. The bearing at the bottom of the post is a part of the bottom plate. This actuating screw swings the quadrant by means of a nut which slides on a guide on the top part of the frame. The bottom plate is provided with four rollers for slewing, that roll on a beveled flange on the post plate.

There are two different compensating devices. The first is obtained by the use of two parallel links pivoted in one end near the top of the jib, and at the other end holding two sheaves over which the hoisting ropes run. This end of the links is held by a chain that runs over the sheave at the top of the jib, and is connected by means of a rod with a three-

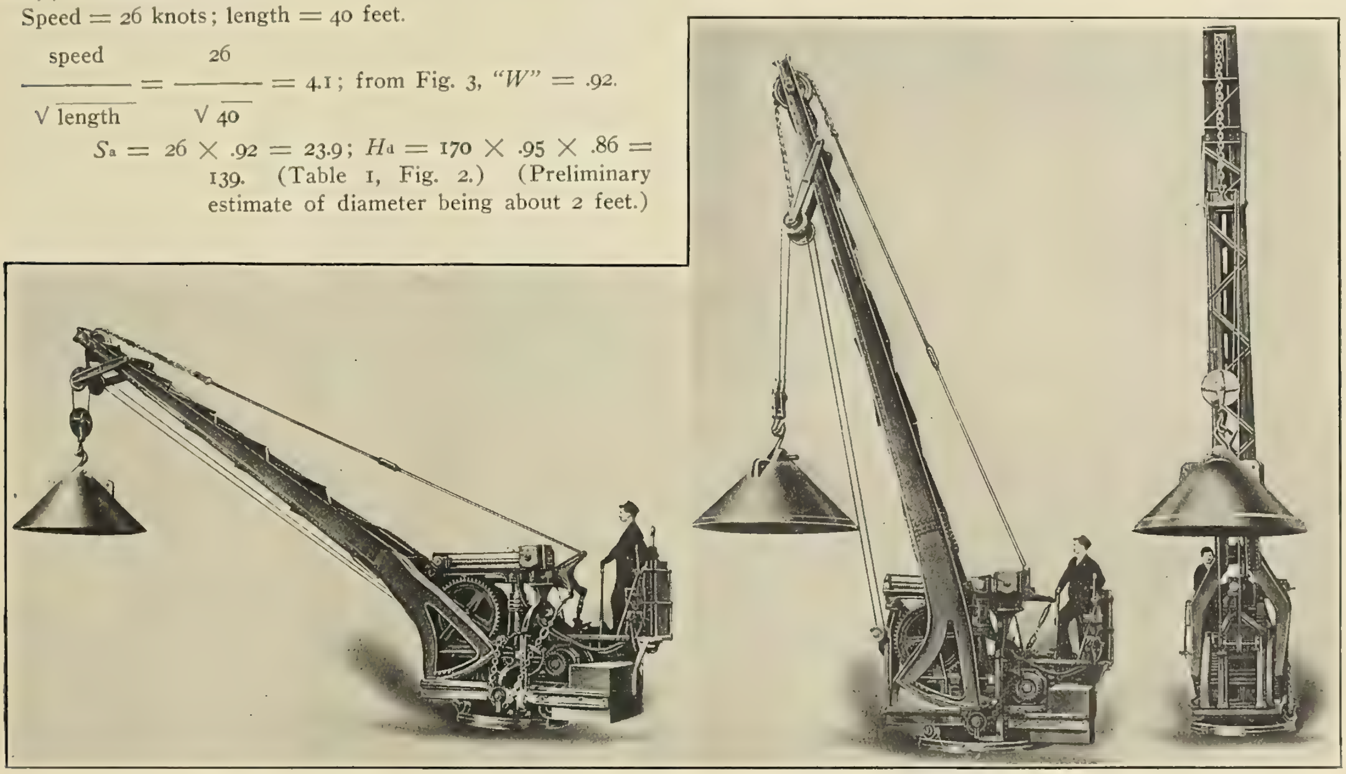

FIG. 1.—2½ TO 4-TON, THREE MOTOR, COMPENSATING QUADRANT CRANE

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arm dog pivoted at the top of the back frame. The other two arms of the dog are connected with the lower back end of the quadrants by means of two chains running over sheaves on the bottom plate.

In the second alternative device for compensation, the fixed end of the hoisting rope is fastened to the jib at a suitable point near the top, and from this point runs back and forth over sheaves on the back part of the frame and on the top of the jib.

The hoisting machinery is of the usual kind suitable for the purpose for which the crane is to be used—that is, hoisting drum, brake, gearing, friction clutch and other necessary one-motor 3-ton crane is shown in Fig. 2, and a 1-ton truck crane in Fig. 3.

Four distinct features make the compensating quadrant crane different from other cranes.

1. The rolling quadrant arrangement giving the jib a movable pivoted point.
2. The actuating screw arrangement with the application and direction of the derricking forces on the jib.
3. The horizontal travel of the load.
4. The compensation tending to reduce bending in the jib in proportion to the load.

The rolling quadrant arrangement is perhaps the most

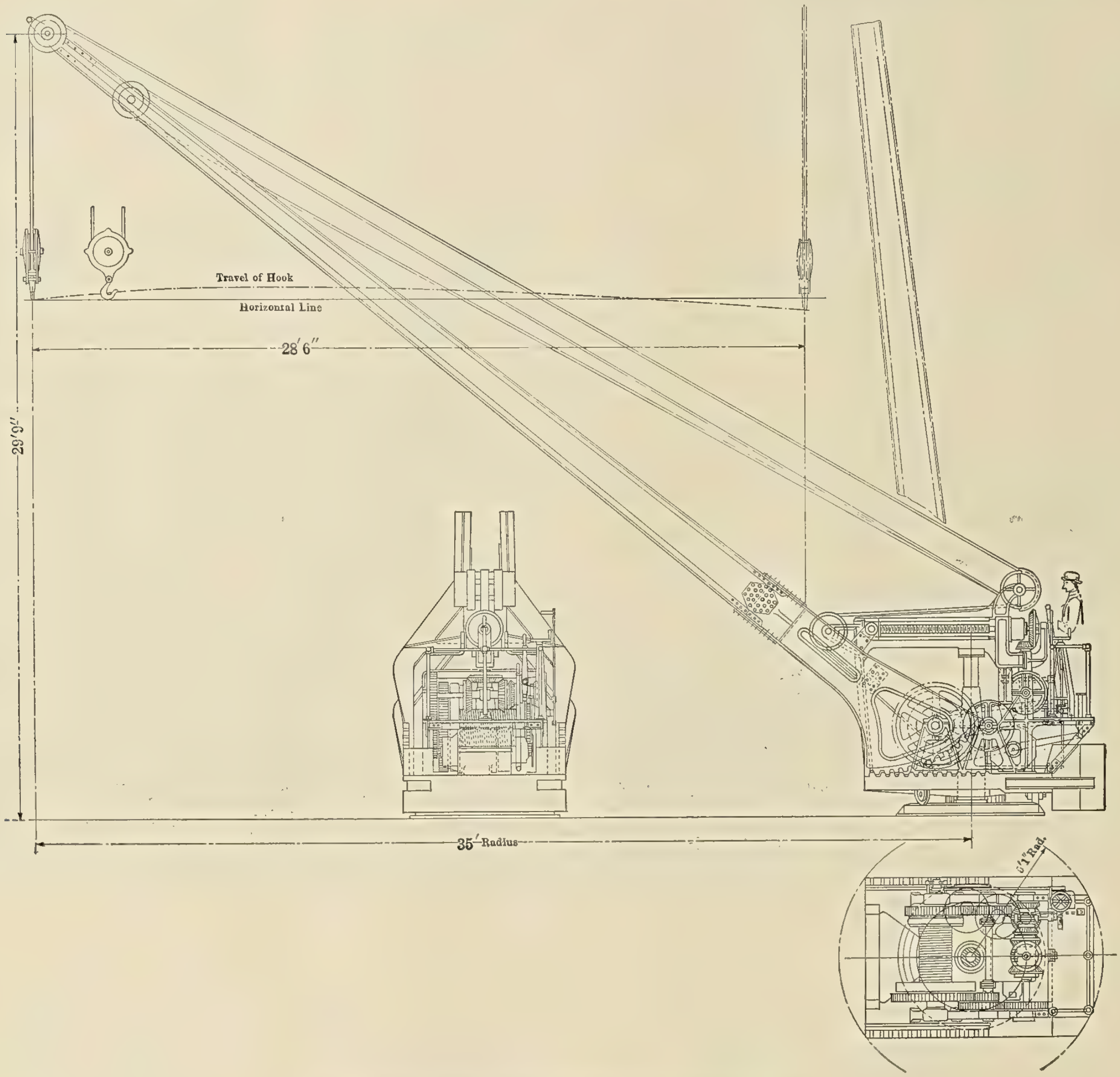


FIG. 2.—ONE MOTOR, 3-TON COMPENSATING QUADRANT CRANE

details. The slewing is obtained by means of a system of gears under the bottom plate, which engages an annular rack in the post plate. The derricking is accomplished by means of the above-mentioned actuating screw, which is provided with a worm or spur gear drive. The necessary counterbalancing is properly cared for by a well-secured weight. The driving power can be of any desired kind, but the cranes here are generally provided with electric motors.

The crane shown in Fig. 1 is a 2½ to 4-ton three-motor crane, one motor for hoisting, one for slewing and one for derricking. Levers, controllers and all other necessary parts for operating the crane are placed conveniently on a platform. A notable feature and gives the crane a distinctive look. It also gives a different arrangement of forces than on other cranes, which can be readily seen on the stress sheets, Figs. 4, 5 and 6, showing the stresses in different positions of the jib.

By rolling the jib on narrow circular flanges of a large radius, and controlling the position of the supporting point by means of a rack, no excessively large bearing surfaces are needed, giving a very large pin friction. The only friction worth mentioning at all is in the rack, and this is almost negligible, as it is spur-gear friction.

As the quadrant is part of a circle that has its center in the center line of the actuating screw, and as this center line is parallel to the tangent of the quadrant at its supporting point, it will be readily understood that the force applied in the screw will always be at right angles to the line between the moving fulcrum and the point of support of the quadrant. That means the maximum leverage, consequently the minimum force needed for raising the jib. The required power for derricking is therefore minimized, and furthermore decreases rapidly the higher the jib is raised. It also follows from this that there is no bending in the screw, only tension.

The above arrangement does not cause any pressure to be communicated along the jib to the point of support. On

FIG. 3.—1-TON TRUCK CRANE

ordinary cranes the derricking arrangement causes a considerable pressure along the jib on the pivot, and to reduce that somewhat, and also to reduce the power required for derricking, the point of the upper support is placed as high as possible, sometimes on a mast or a structure. This increases the amount of material and necessitates guys and stays, thus materially reducing the slewing angle.

On the compensating quadrant crane this is absolutely unnecessary, and a low, compact arrangement can be used, giving a clear swing of 360 degrees.

The compensating arrangement, as previously mentioned, has two distinct functions. The most important one is to give the load a horizontal travel. The two different arrangements mentioned before show practically the same result, and the travel of the load is clearly seen on the stress sheets. At the beginning the path of travel rises from 1 to 3 inches. It is intended not to compensate for this small rise, as it eliminates the necessity of hoisting the load to clear before derricking, thus utilizing the least amount of power and reducing the time for loading and unloading. With a multiple speed crane of this type different sizes of loads can be taken readily without changing the gearing.

That it is advantageous to have the load traveling in a horizontal line is readily understood when one considers that to move a load horizontally requires practically no power. It is only necessary to apply power enough to bring the load up to the required horizontal speed. The power that is required for derricking is used in raising the resultant center of gravity of the moving parts to give the accelerated horizontal motion at the start and to overcome friction. In an ordinary crane the load is raised considerably when derricking, thus requiring an extra amount of power over that used in a compensating quadrant crane, and consequently increasing the running cost of the crane.

The compensating devices have still another important influence on the working of the compensating quadrant crane. By the arrangement of the two links in the first-mentioned device it can readily be seen on the stress sheet, Fig. 4, that these links materially reduce the bending and the pressure on the jib, while at the same time they help in making the travel of the load horizontal. Furthermore, those links tend to steady the sheaves over which the hoisting ropes run.

By means of the chains, the rod and the dog which connect

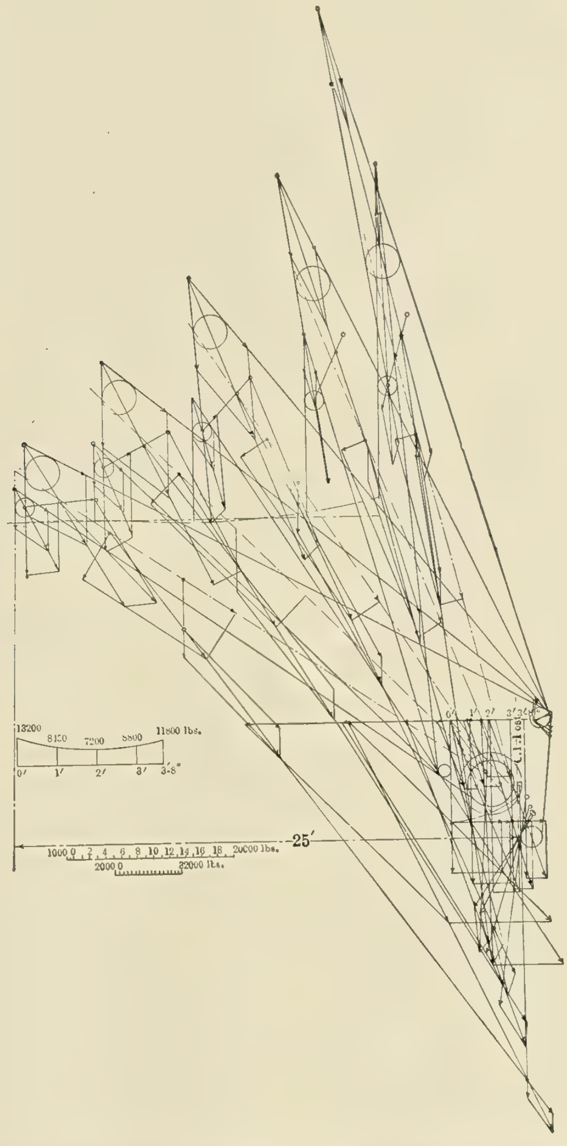


FIG. 4.—STRESS DIAGRAM FOR 2½ TO 4-TON COMPENSATED QUADRANT CRANE 25 to 20 FEET OUTREACH

the links with the quadrants, a force is produced that tends to reduce the tension in the actuating screw. The direction of the pressure transmitted through the dog on the top part of the aft frame is such that a lighter construction of the framework is possible than if a stay was connected to the frame, as is done in an ordinary crane. The first gives a downward pressure, as against an upward pull as well as bending in the latter.

With the second compensating device a practically horizontal travel of the load is obtained when derricking; at the same time a considerable force is produced that reduces the bend-

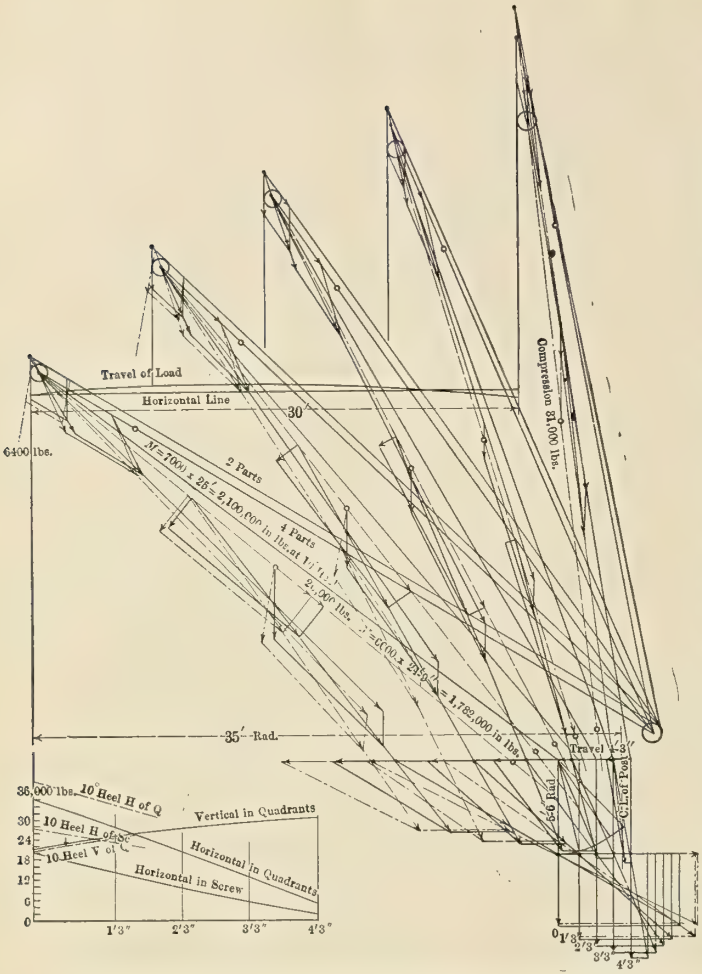


FIG. 5.—STRESS DIAGRAM FOR 3-TON, 35-FOOT COMPENSATED QUADRANT CRANE

ing force on the jib and the tension in the actuating screw, as can be seen in Figs. 5 and 6.

In both cases the compensating action of the forces is more and more effective as the load increases. This is one of the important features in the compensating quadrant crane, and which accounts for the relatively small increase in the derricking power needed for a large increase of the load. A convincing example of this fact is that on the crane shown in Fig. 1 the increase in power necessary for derricking was only about 30 percent from no load to full load. In considering the amount of power needed for derricking one must remember that the power decreases rapidly as the jib is raised.

The above-mentioned facts prove clearly that in this new type of crane the power and therefore the cost of derricking is reduced to figures never before possible. The importance of this fact is self-evident.

It is obvious by the action of the compensating devices that the dimensions of the jib can be materially reduced as compared with an ordinary crane, which is, of course, a much desired feature. Not only the weight of the crane but also the necessary counterweight is reduced. The construction is simplified and the number of parts are reduced, as can be seen on the plans, thus reducing weight, cost and space. It therefore follows that this crane, owing to the compactness of the design, can be used where other cranes would not be available.

A splendid example of this is the truck crane shown in Fig. 3. This is claimed to be the only type of crane that has worked out satisfactorily on self-loading motor trucks.

It is impossible in this article to more than mention a few of all the different arrangements and classes of work for which this crane can be used to advantage. Many new fields of vast importance are opened through the use of this crane. As an example, there is a tandem arrangement worked out which will double the capacity of the ordinary crane, but can be handled by only one man.

On the stress sheet, Fig. 6, the layout of a 20-ton crane is shown. The jib is arranged on the crane so that it can be lowered down to a horizontal position. In this position the jib will stand a load of about 10,000 pounds, making possible the handling of smaller loads at a considerably greater radius than in the usual arrangement. It is very interesting

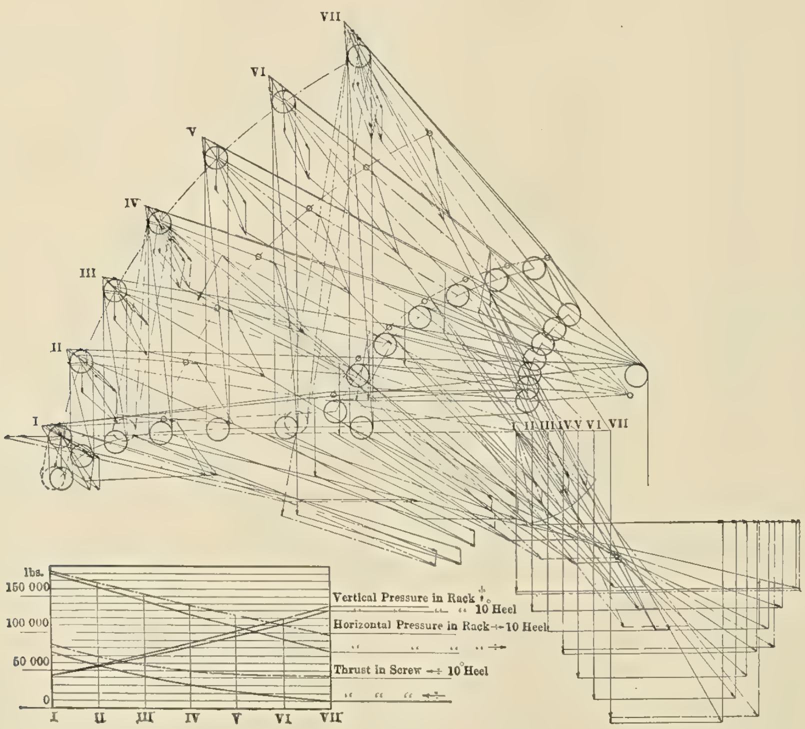


FIG. 6.—40,000-POUND COMPENSATED QUADRANT CRANE

to note that in this severe condition, in the line of travel of the load, there is only a comparatively slight rise in the beginning, and from there on a practically horizontal line. The jib of this crane can very readily be raised to its working position, thus making this type of compensating quadrant crane especially adaptable for locomotive cranes, wrecking cranes, battleship cranes, etc.

In connection with the easy manner in which the jib can be raised, it is worth while to point out another important feature: when an unusually heavy load is going to be handled, and slewing is necessary, the easy derricking of the jib makes it convenient to bring the load in near the center of the crane and then slew it, after which the jib is let out again to place the load in the desired position. The advantage of this on board ship when the ship has a list is obvious.

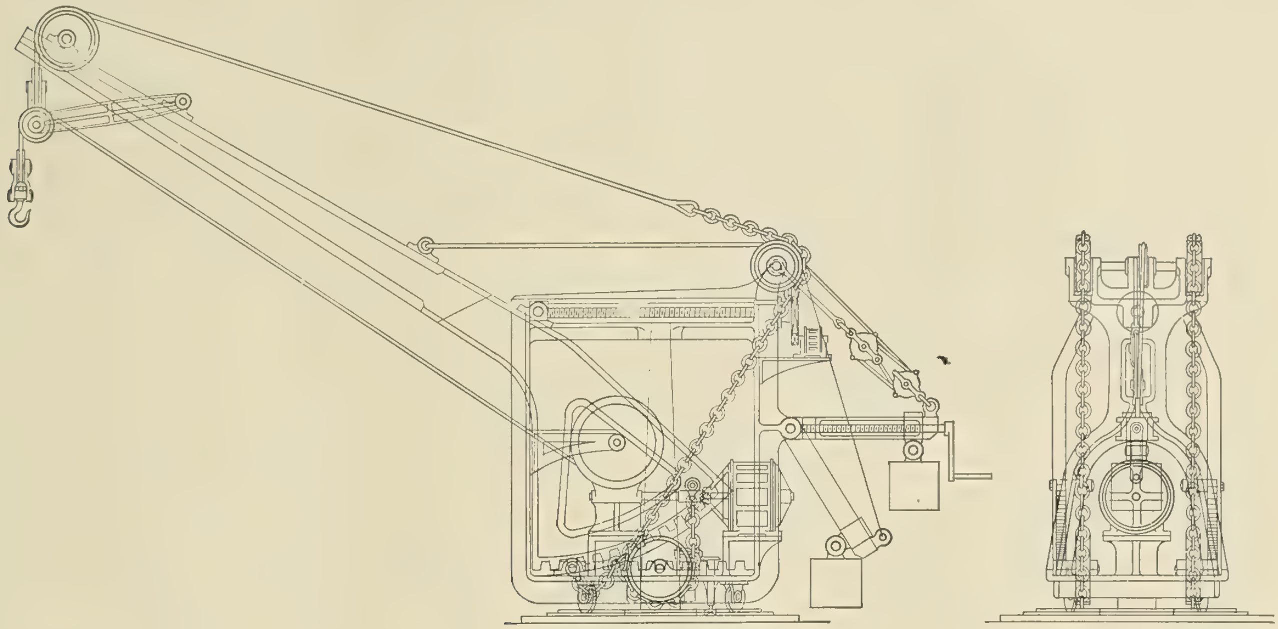


FIG. 7.—NEW COUNTERWEIGHT ARRANGEMENT ON COMPENSATING CRANE

Another arrangement is with a variable quadrant radius, thus making still further compactness available in the crane. This is of great advantage in larger sizes.

The new counterweight arrangement shown in Fig. 7 will prove of special advantage in large cranes, as the effect of the counterweight is automatically regulated to suit the different positions of the load. At the same time the pull on the jib will tend to materially reduce the tension in the actuating screw, thus still further reducing the power needed for derricking. In a few words, the counterweight acts also as a compensating device on the jib.

In the cranes of this type steel castings of best grade are used wherever possible, and all other parts are made of the most suitable material. The actuating screw, for instance, is made of the best nickel steel. Ball bearings are provided at several points of contact, thus reducing the friction, and therefore the running cost of the cranes. The cranes are sold by the Welin Marine Equipment Company, 305 Vernon avenue, Long Island City, N. Y., and the La Salle Machine & Tool Company, of La Salle, Ill. In Europe they are sold by the Welin Davit Engineering Company, 5 Lloyds avenue, London.

In conclusion, I wish to give a summary of all the advantages distinctly characteristic of the compensating quadrant crane as follows: 1. Money saving, as less power is needed. 2. Time saving, by speedier load handling. 3. Less space needed. 4. Less weight. 5. Less machinery. 6. No mast or mast guys. 7. Easier to operate, being more compact. 8. Full swing of 360 degrees. 9. More adaptable.

5,000 Horsepower Motor Ship for the United States Navy

During the last regular session of Congress an appropriation was made for two oil fuel carriers. For one of these ships, the *Maumee,* the Navy Department has just concluded a contract with the New London Ship & Engine Company, Groton, Conn., whereby that company will supply complete working plans for two large oil engines of the Nuremberg type. While the exact details in regard to the ship and her engines are not available, it is definitely known that there will be two engines, each of six cylinders and developing 2,500 horsepower, making a total for the ship of 5,000 horsepower. Up to this time the largest marine engine to be built in the United States is one of 1,000 horsepower for the submarine tender *Fulton,* for which the New London Ship & Engine Company has a contract.

It is interesting to note that the advantages of oil propulsion are so well recognized that there have already been built abroad over seventy-five vessels exceeding 100 feet in length which now use oil engines. Fifty-three other vessels are now building, some of them even larger than their predecessors, all using internal-combustion engines of the Diesel type. The aggregate represents something like 100,000 horsepower now used for marine purposes in large ships.

The subject of large oil engines for naval vessels is a live one, and has received the attention of all the principal European powers. Germany is experimenting with engines of 12,000 horsepower for battleships. France is doing likewise, England is building a number of large oil fuel carriers equipped with these engines. But, in point of size, the United States Government has selected the largest engine yet undertaken for a cargo vessel. In this way the Government is placing itself in a position to go ahead with still larger engines for naval vessels when the time arrives.

LAUNCH OF *H. M. S. Haughty.*—Messrs. Yarrow & Company, Ltd., Glasgow, launched recently the destroyer *Haughty,* 220 feet long, 27 feet 6 inches beam. The main engines consist of a two-shaft arrangement of Brown-Curtis turbines. Steam is supplied by three Yarrow boilers fitted with patent feed heating and superheating arrangements and designed for burning oil fuel exclusively.

McAndrew's Floating School

BY CAPTAIN C. A. McALLISTER *

CHAPTER XI

Engine Fittings

"As we look into the fittings which go on a boiler we should also pay some attention to what are known as engine fittings.

"The principal of these is the throttle valve, by means of which the engine is started or stopped at will. It is customary to bolt the throttle direct to the high-pressure valve chest, and to operate it by means of a lever and rods from the working platform. The most generally used type of throttle valve is known as the double-beat valve, the general principles of which are shown in Fig. 18.

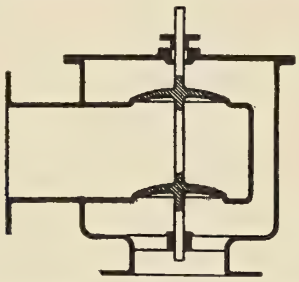


FIG. 18.—DOUBLE BEAT POPPET VALVE

"This is really two valves in one, the steam entering through two openings in the valve casing. The two disks are worked on one stem, the upper disk being made slightly larger than the lower one, so that the tendency is always to close the valve. However, this difference in the load on the two disks is so slight that it can readily be overcome by means of the throttle-working lever. This lever works on a notched quadrant, and it is held in position by means of a spring latch. In practical working of a throttle you will find that it only needs to be opened a very slight amount in order to work the engine 'to bells,' as it is termed.

"Right here it may be well to inform you that a valve does not have to be opened very far to secure a full opening, or to have it 'wide open,' as the term is. A little figuring will illustrate the idea. For example, if you are using a throttle 10 inches in diameter, its total area is 10 by 10 by .7854 = 78.54 square inches. That is, to find the area of a circle you multiply the diameter by itself, or square it, as the mathematicians would tell you, and then multiply that product by the constant .7854. To find the circumference of a circle you multiply the diameter by the constant 3.1416. This last constant is known as 'pi'; now don't be alarmed, O'Rourke, for that is not the kind you eat, it is simply the Greek letter that is selected to represent the ratio between the diameter and circumference of a circle. The circumference of a 10-inch circle is 31.416 inches. Dividing 78.54, the area in square inches, by the length of the circumference, 31.416 inches, you will find the answer to be 2.5. In other words, a 10-inch throttle valve has to be opened only 2½ inches to be wide open. You should also note that 2½ is just one-fourth of 10, and bearing in mind that the ratio between the circumference and diameter of all circles is the same, you will see that any valve has to be raised only a distance equal to one-quarter its diameter to be 'wide open.'

"Most valves are designed to allow a larger opening, but you will see from the illustration that it is not necessary to jam a valve open as far as it will go in order to get the full area through it."

"Isn't it possible to get a triple-expansion engine stuck on a center?" asked Pierce.

"Yes, it is not only possible but it occurs quite frequently," answered McAndrew. "To avoid trouble of this kind all compound and triple-expansion engines are fitted with what are termed 'pass-over valves.'"

"That must be a Jew valve!" suggested O'Rourke.

"This is hardly that kind of a valve," continued the instructor. "The necessity for such a valve occurs when the high-pressure crank is on the top or bottom center, a condition which generally arises at the most inopportune times, such as working the vessel into a dock. However, by quickly opening the pass-over valve, a small stop or slide valve, live steam is admitted into the intermediate valve chest, which starts the intermediate piston in motion and pulls the high-pressure crankpin over the center. The hand-wheel or lever for controlling the pass-over valve is always located at the working platform within convenient reach of the man operating the engine."

"Why are drain valves necessary?" asked Schmidt.

"Because steam when entering a cold cylinder or valve chest is condensed into water, which, if not allowed to drain off, would cause a water hammer and might break a cylinder head. Drain valves are located at the bottom of each valve chest and cylinder at the lowest points. Sometimes they are operated by means of an extension rod and a hand-wheel at the side of the cylinder, but more often by means of shafts and levers located close up to the working levers, so that the man operating the engine can open or close the drain from any cylinder without leaving his position.

"Relief valves are located on each valve chest and at the top and bottom of each cylinder. These are, in reality, small safety valves, similar to those used on boilers, and are for the purpose of automatically relieving any excess pressure, either of steam or water, mostly that caused by water, in the cylinders."

"What is the use of a turning engine?" inquired Nelson.

"That's easy," volunteered O'Rourke. "It's to keep us horny-handed sons of toil out in the fire-room from breaking our backs by jacking the old engine over every day!"

"Judging from some firemen I have had with me," replied McAndrew, looking straight at O'Rourke, "working the turning gear is about the only real work you can get out of them while the vessel is in port.

"Turning-engines are not usually fitted on engines of less than 3,000 horsepower, as it is much simpler to have the ordinary hand gear, which usually consists of a large worm-wheel secured to the crankshaft just aft of the engine bed-plate; a small, vertical or inclined shaft pivoted at the bottom works the worm, which meshes with the main turning wheel, the shaft being operated by a ratchet lever. If steam power is used it is usual to drive the worm-wheel by means of one or two small cylinders, the whole apparatus being so geared that it takes hundreds of revolutions of the small engine to turn the main engine over once."

"Why do you have to turn the main engine over when steam is not on it?" asked Pierce.

"It is quite often necessary to do so when making adjustments to the crankpin brasses, in order to get the particular crank on the top center; sometimes it is necessary to jack the

* Engineer-in-Chief, U. S. Revenue Cutter Service.

main engine over while adjusting the valve gear. All engines in which metallic packing is used for the rods should be jacked at least once each day, in order to prevent rough places being formed on the polished rods from standing too long in contact with the packing at any particular point of the stroke.

"Leaving the main engine and looking aft, the first thing of importance we see is what is known as the 'thrust bearing,' a most important element in steam machinery, as it is by means of this piece of mechanism that all of the driving power of the propeller is transmitted to the ship itself.

"As the propeller revolves in the water it has the same tendency to advance that a screw has in a piece of wood, and it is this pushing effect, or thrust, as it is called, which, transmitted through the agency of the shafting and the thrust bearing, drives the ship along. This bearing therefore must be firmly secured to the hull of the ship, and must be so designed as not to become overheated on account of the necessarily large amount of friction on the bearing surfaces. That part of the shafting upon which the thrust bearing is located is known as the 'thrust shaft,' and it is usually made short in length in order to facilitate its removal from the ship when it becomes necessary, as may happen, that it has to be placed in a lathe for the purpose of removing the scores from the bearing surfaces. On this thrust shaft are a number of solid rings or collars, which fit between what are known as 'horseshoe collars,' and which are supported on rods on each side of the bearing, each being provided with two adjusting nuts on the rods, so that each individual horseshoe may be adjusted to bear a proportionate amount of the thrust of the shaft. The bearing faces of these collars are lined with white metal, so as to reduce the friction to a minimum. The bottom of the bearing usually forms a rectangular tank or trough, which is filled with oil so that the collars on the shaft revolve in it and carry the lubricant to the bearing surfaces. To keep the bearing cool it is customary to fit a flat coil of pipe in the bottom of the oil reservoir, and to connect this coil to the water circulating system. The best thrusts also have separate water pipe connections to each horseshoe collar. Too much attention cannot be given to the thrust bearing, for if it is not properly oiled and cooled a great deal of trouble can arise on account of excessive heating.

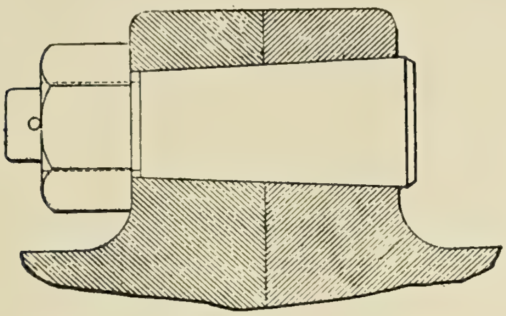


FIG. 19.—DETAIL OF FLANGE COUPLING AND BOLT

"Just aft of the thrust shaft, the main or 'line shafting' extends to what is known as the 'tail shaft,' the last portion of the propeller shafting. This line shafting is known as the intermediate shaft, and is made in one, two or three sections, according to the length of the vessel. All lengths of the shafting proper are made of the best quality of wrought steel, and they should be carefully forged and inspected, as the breaking of any part of this important connection between the main engine and the propeller totally cripples the ship if she is of the single-screw type. It is customary to connect the several sections of the shafting together by means of what are known as flanged couplings and tapered bolts, as shown in Fig. 19.

"The bolts are made tapered for convenience in backing them out whenever it becomes necessary to remove a section of the shaft.

"Each section of the intermediate shafting is usually supported on two bearings, which rest on suitable foundations of plates and angles built up from the frames of the ship. These bearings probably have more names than any other part of the steam machinery. Different people refer to them as 'spring bearings,' 'pillow blocks,' 'tunnel bearings,' 'steady bearings' and plain bearings. However, no matter what they are called their function is a very simple one, namely, that of supporting the weight of the shaft and keeping it in alinement. With such simple duties to perform, it is customary to fit the bottom with a brass, or to line it with white metal. The top of the bearing serves no other purpose than to keep the dirt out of it, and to support oil cups or compression cups containing grease for lubricating purposes.

"Inexperienced oilers, like O'Rourke will probably be, pay a great deal of attention to spring bearings, but the old timers give them a familiar slap in passing, as they know that bearings of this kind seldom give trouble from overheating.

"In single-screw vessels the tail shaft, or propeller shaft, passes through what is known as the 'stern tube,' a heavy cylindrical iron or steel casting extending from the after bulkhead of the shaft alley to the eye of the stern post. It is advisable, and also customary, to increase the diameter of the tail shaft over that of the intermediate shafting, as where it passes through the stern bearing it is not possible to inspect it often, and being constantly immersed in salt water it may become badly corroded. To provide against this corrosion the tail shaft is usually encased in composition sleeves shrunk on the shaft by heating the casing before it is slipped in place. By carefully soldering the ends and the joints between the sections of the casing, the water is usually kept out, but unless the soldering is well done the water is liable to leak in and cause havoc to the shaft.

"At the forward and after ends of the stern tube, bearings are formed of composition castings containing dovetailed grooves. In these grooves are strips of lignum-vitæ, a tropical wood and about the hardest that grows. The bearing surface should be on the end of the grain, and the strips should be well soaked in oil before being driven into place, as the water which circulates around the shaft is the only lubricant it receives. At the inboard end of the stern tube there is a

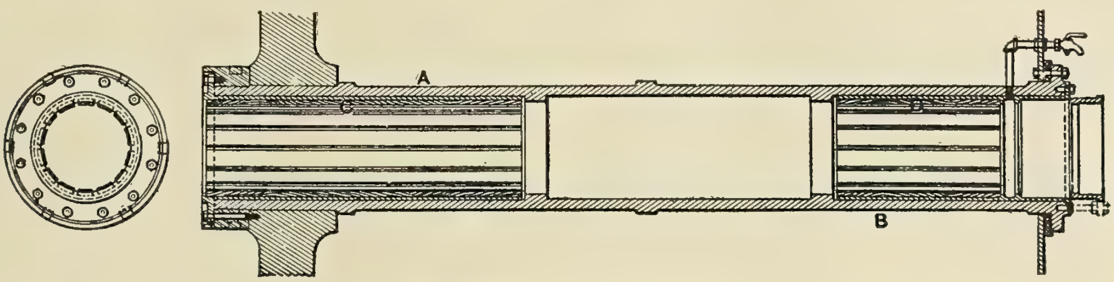


FIG. 20.—STERN TUBE AND BEARING

stuffing-box packed with square hemp or flax packing, a job which can only be attended to while the vessel is in the dry dock. There is usually fitted a small cock and a pipe leading to the water space, by means of which a small stream of water is allowed to trickle on the stuffing-box and its gland in order to keep them cool. This also allows a circulation of the water in the stern tube.

"In sandy or muddy water the lignum-vitæ in the bearings is found to cut out quickly, and in some vessels it is customary to fit a stuffing-box at the after end of the after bearing and to line the stern bearing with white metal. Lubrication is furnished to such a bearing by means of an oil cup or compression grease cup located above the waterline in an accessible position.

"Fig. 20 will show the usual form of stern tube, bearings, etc., used on single-screw vessels."

(To be continued.)

Letters from Practical Marine Engineers

Incidents Relating to the Design, Care and Handling of Marine Engines, Boilers and Auxiliaries; Breakdowns at Sea and Repairs

Retarders for Tubes

The usual design of retarder is shown in Fig. 1, and consists of a steel rod round which steel wire is wound. This method involves considerable labor in the fitting, as unless the wire is very carefully wound a good lot of filing will be necessary before the apparatus is a good fit in the tube. The

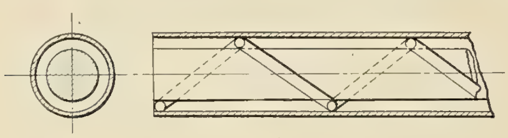


FIG. 1

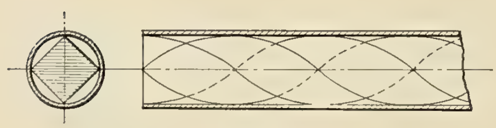


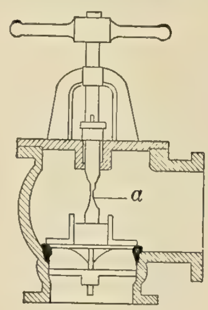
FIG. 2

following method (Fig. 2), put into practice on some recent steamers, is cheaper and easier to produce. A steel bar of square cross-section is procured and ground so that it is an easy sliding fit in the tube. This bar is then heated and twisted into a spiral form, after which it can be fitted into the tube without much further trouble. In any case if it is a trifle too large it is much easier to touch up the corners with a file than to fit the other design of retarder. "Ison."

Glasgow.

Electrolysis

For two years when the vessel went for the annual docking, repairs and examinations, we had found the valve stem of the 16-inch suction valve from the engine room bilges to the centrifugal circulating pump (used to cool the condenser), as at *a* in the accompanying sketch. The first year it was considered that the stem had been made from a poor piece of metal (rolled composition), and a new piece of rolled material was procured and a new stem made. The ship was tested out for grounds to prevent electrolysis, and plenty of zinc was fastened to the valve and valve body, but at the next annual overhauling and docking it was found worse than before at the corroded part *a*. The diameter was less than a quarter inch, but the valve body was not corroded at all. The previous year the company had been notified of the facts, and the stem had been sent to show what electrolysis was doing to us. On being notified the second year that the stem had been found in the same condition, they suggested that we make a stem of cast brass. This was done, the zinc renewed, and we never had any more trouble from same. It dawned on me then that the body was not attacked on account of being cast brass, and on examining the metal in the stems for the injection and overboard discharge, it was found that they were made of cast brass, and they had never corroded. I am not



WASTED VALVE STEM

stating that all valve stems that are surrounded with salt water should be made from cast brass, for ours may have been a peculiar case of electrolysis, for we all know that it is a mysterious thing at best, and does not always seem to attack metals in the same way; but from this experience, after trying the usual preventatives and not being successful, my next step would be if possible to change the composition, so that it would be like something near by which was not being attacked.

Repairs.

Quick Repairs on a Broken Valve Guide

A vessel equipped with a 5,500 horsepower engine of the inverted type was running about half speed in a heavy seaway when the valve guide, located aft of the low-pressure cylinder, broke. The crack started 4 inches from the top on the inboard side and ended 8 inches from the top on the outboard side. As the engine was stopped immediately, no harm was done to the valve gear. The valve crosshead carried two low-pressure piston valves, the guide was of the usual type bolted to the lower valve covers and projecting down through the center of the crosshead. When the engine was stopped, the part of the guide below the break fell down on the eccentric straps. The engine was in a helpless condition, and, as the vessel was in a heavy seaway, immediate repairs looked remote to me.

In this case a valve guide was certainly necessary to turn the engines over again, and I could see nothing else to do than to lay there and roll until we disconnected the low-pressure cylinder and compounded the engine. Altogether this was not a nice job to undertake in such a seaway, for it would take at least two or three hours before the engines could be started again, but I was so sure that this was the *modus operandi* that I had the engine secured in the shortest possible time and commenced to get out the necessary wrenches, slings, falls, etc., to strip the low-pressure engine. Meanwhile a messenger was dispatched to the chief engineer's room to awaken him and inform him of the trouble, for this was 2.30 A. M. Such things, by the way, always seem to happen at night.

When the chief arrived in the engine room he looked at the broken guide on the floor plates and the part that remained in place, and then said: "Bring out a short jack and a hand saw." I thought that it might be possible that he was not quite awake yet, so I ventured the remark, "Is it a hack saw that you mean?" for I could not see anything that could be done with a wood saw nor with a hack saw either, as far as that is concerned; but, no, it was a wood saw that he wanted, and he said so with a few emphatic remarks.

In one of the bunkers we had some 8-inch by 8-inch and one piece of 12-inch by 12-inch yellow pine 10 feet long, which I had tried to put ashore before sailing, as it seemed like useless luggage, but I was told that it would not cost much to carry them, and so they stayed on board. We were told to get out the 12-inch by 12-inch piece and two pieces of the 8-inch by 8-inch. Then with a chain fall we pulled the broken piece back in position, sawed off two pieces of the 8-inch by 8-inch and set one piece on the forward bearing of the thrust block and the other piece on the top of the after main bearing. We then placed the 12-inch by 12-inch piece on top of them, resting the jack on the same and setting it up on a block that rested on the end of the broken guide. This held the lower end solid and the top end was held firmly by the ragged edges of the break in the cast iron, which fortunately was nearly flat. The corner of the 12-inch by 12-inch piece was cut off to let the guide head eccentric rod work up as close as possible. Two blocks were driven in between the uprights and engine frame. The outer ends were held in place with chain falls and the inner ends spiked.

The engine was started in just fifty-five minutes after the guide carried away, and the ship's head was put up to the gale again. The patch held until we reached port, where a new one was fitted. The only fault was that the engine could not be run quite in full gear, as the go-ahead eccentric rod had to be kept clear of the 12-inch by 12-inch cross piece.

A Reader.

Marine Engineering in the Good Old Days

Thirty years ago the writer began his career as a marine engineer by shipping as oiler on a coasting steamer. This was a screw-propelled, wooden vessel of about 1,000 gross tons, fitted with a single engine, 40 inches diameter of cylinder and 42 inches stroke of piston, with hook motion and jet condenser. Steam was supplied from a three-furnace Scotch boiler carrying 30 pounds steam pressure. It is difficult for a young engineer, trained on a modern steamship, to realize the advance that has been made in engineering since that time.

On this ship nothing but soft packing was used in piston rod and valve stem stuffing-boxes. Pumps were all packed with hemp packing laid up by hand, and it was no mean job to lay up the different sizes of packing used—4, 8, 12 and up to 24 strands. Compare this with the machine-laid packing used to-day.

Common rubber was used for joints almost exclusively. It was considered quite an advance in joint packing when we got Usidurian. And how many different ways there were of handling this. One engineer would not allow a wrench used on a joint while it was hot, but would wait until the trip was ended and the joint cooled off before taking up on it. Of course, a joint blew out occasionally, but he considered this one of the fortunes of war. The question comes as to what he would do with it in these days of high steam pressure.

On the ship above mentioned common lamp wick, soaked in white or red lead paint, was run around the cylinder flange, inside of the studs, for a cylinder head joint, and when an asbestos joint was proposed the chief engineer protested on the grounds of excessive expense.

It was the practice of engine builders up to about that period to make the journals, particularly the crosshead guides, as small as possible to reduce friction, they considering that the more square inches of wearing surface the more friction. We now know that the pounds friction on a journal is a fixed quantity, and the larger the journal the less friction there is per square inch, therefore the easier working journal. All kinds of lubricating compounds were used on journals in those days, varying according to the ideas of the engineer in charge. Lard oil was the common lubricant, mineral machine oil being a later development, and this would be mixed with tallow and plumbago or black lead, sometimes white lead or softsoap, to use on a journal that was subject to chronic overheating.

The use of tallow for cylinder lubrication was just about abandoned then, mineral oil being substituted, although some of the then old-time engineers had serious doubts about mineral oil being able to lubricate anything, unless it was the oil salesman's tongue. Sight-feed cylinder cups for feeding oil to the cylinder were in their infancy, and all sorts of ideas were rampant as to the proper method of attaching them. Some engineers contended that they would not work without a large reservoir for water in the pressure pipe; others that the pressure pipe must be led direct from the boiler, and considerable ingenuity was displayed by all in keeping the body of the oil cup warm and the water reservoir cool.

No engineer in those days believed that a boiler would deliver dry steam without a capacious steam dome or chimney, yet even with these the boilers of that period were notorious for their foaming proclivities. A common remedy for this at that time was the injection of about a quart of fish oil through the feed pump, a small connection being attached to the suction side of the pumps for this express purpose. Imagine doing this to-day with our high steam pressure, surface condenser-fed boilers! With the old low steam boilers fed with salt water from a jet condenser, grease in a boiler was not much of a factor.

What a job there was scaling boilers each trip, and what a variety of tools was devised for the removal of the scale! About the only boiler compound in general use then was common kerosene (paraffin), or coal oil, as it was called, and the writer knows from experience that it would "accomplish that purpose whereunto it was sent"—that of penetrating the scale. Of course, it sometimes penetrated through the tube sheets around the tubes, causing them to leak, but that was also a fortune of war. A case of another boiler compound that came under the writer's notice was where a cargo of molasses in hogsheads leaked into the bilges, and it became necessary to use the bilge injection to keep the ship free of water. The boiler was fed from this water, and when it was opened all the scale had fallen off the tube sheets and furnaces to the bottom of the boiler. What effect the continued use of molasses as a boiler compound would have on the boiler itself remains in doubt.

Independent pumps of that date were mostly of the crank and fly-wheel type, there being a few of the direct-acting type, but not then in common use. These pumps took up a large portion of the engine room space and were usually placed in some inaccessible corner, so that it was necessary to stand on your head to pack the water end, which with the hand-laid packing used had to be done frequently.

Air pumps were all attached to the crosshead, and were fitted with single valves, one suction, one bucket and one delivery valve. These were made of soft rubber, and would swell up to twice their original thickness after a couple of months' use, becoming soft and flabby and then tearing. Few of these valves had a straight lift, but were fastened in the middle and curled up at the circumference around a convex guard. Fortunately, the water delivered from the jet condenser was not very hot, so that this style of valve answered the purpose.

In one particular the practice of that period was superior to the practice of the present time, and that was in the complement of the engine room force. On the ship mentioned in the beginning of this article two engineers, two oilers, three firemen and two coal-passers were carried. The writer was chief engineer of a coast towing steamer of nearly 700 gross tons in late years, on which exactly the same complement of engine room force was carried. In the first vessel the only auxiliaries were two hoisting engines on deck and a donkey pump in the engine room; while the last one mentioned had as auxiliaries a donkey pump, sanitary pump, wrecking pump, independent feed pump, circulating pump, electric light engine, steam steering engine, steam capstan, steam windlass and steam towing engine, in addition to having triple-expansion engines, as against the single engine and two boilers as against one. It can readily be seen that even with the same lay time in port there was considerably more work to be done to take care of the modern vessel than the older one. When we stop to consider that this older vessel was only under way about 80 hours in a week, while the later one only stopped about 6 hours a week on an average, it may be taken for granted that marine engineering thirty years ago was not the strenuous occupation it is to-day.

More and more is being demanded of the marine engineer. In a modern ship the engineer is called on to furnish the light, heat, power for steering the ship and getting the anchor, power for getting the cargo in and out and hauling the ship around the docks, keep the lavatories and the steam tables and boilers in the kitchen and pantries in working order, and many other details in addition to propelling the vessel, and while wages have advanced some during the period treated of in this article, they have not advanced commensurate with the extra labor and skill demanded, not to speak of the increased cost of living, which affects the marine engineer and his family in common with all classes of working men.

It is to the credit of the marine engineer that his intelligence and capabilities have equaled the demands; in the old days they fulfilled all requirements, to-day they do the same.

J. S.

[The old vessels referred to in this article are not to be understood as being ships built or building thirty years ago, but ships built previous to that time and in operation then.]

The Education of a Young Mechanical Engineer

Of late years much has been said, and many plans have been devised, for the education of the young men who are required to take the place of the "Old School" engineers, who are gradually giving way to the college-trained men. Some of these plans are excellent in their make-up, but incur many difficulties and inconveniences on account of their arrangement, and the amount of trust put in a school boy. This is wrong, as I will explain further on.

Many prominent engineers have suggested sending the young men to college directly they have finished at the grammar school without a preliminary knowledge of practical engineering, but this I consider to be a great mistake. If the above course is followed, the youth goes to college feeling very important, but forgets the real reason for which he went. When a professor commences to lecture on glands and stuffing boxes, he is lost, and the subject holds little interest for him afterwards; so what does he do? Well, he will say to a few friends, "Prof. Witt is lecturing on packings to-day, so let us slack." This he does, and, unfortunately, the longer he is at college the more frequent it becomes, naturally with a disastrous ending to his education. It is not that the education is inadequate. No! not by any means, but because the student cannot get interested in what is being said. He is inclined to give too much time to sport and pleasure, simply because he knows practically nothing about the simple steam engine and workshop practice. Now, again, if the same youth goes into the workshop during the summer vacation, he is looked upon by the foreman as one who is to do as little as possible because he has been to college, with the result that his hands are in his pockets most of the day; therefore he gets fed up with what he has not to do, the interest is lost, and all he wishes for is 5 P. M. Now, such a state of affairs is detrimental to the youth, and his education suffers accordingly.

What is wanted to-day is a practical man theoretically trained. The question might be asked, How is the young man going to get the necessary training? Well, a building won't stand without a good foundation; so the same with a youth. Give him a good foundation and he will make good. Now the only way he can acquire this is to go to the shops for four years, after having passed through the grammar school. When he has been there a few years he realizes the meaning of the word "responsibility," and so, when he eventually goes to college, he is a man and understands the full value of the education he is still to obtain. His mind is filled with one thought: "I am here for a purpose, and that is to become an engineer." So, with this thought constantly in mind, he sets to and works for something tangible. After such a long time in the shops he is sure to find a difficulty with mathematics at first, but at the present time mathematical classes are so arranged at the technical colleges to suit the ability of the student, and with a little hard work this difficulty can be mastered. His thoughts are not so easily diverted from his study as the youth who has come direct from school to college, and he is better prepared for hard work and concentration; he can follow his professors' lectures and knows how to apply them in practice. The other youth considers his college life to be a time for pleasure, as he believes it soon enough to work after he gets out into the world, but I think it is recognized that the time to learn is when one is young. This might not be the case with all, but I should certainly put it at about 80 percent.

Having mentioned the aforesaid, I will take the liberty of putting forward a course of training which I consider adequate for a youth who intends to become a mechanical engineer.

The boy should be kept at school until he is 15 or 16 years old. He is then sent to the shops for four years (a small shop being advisable for the first three years, with the fourth devoted to erecting work in a large engineering works, where an insight into large constructional work may be had). During this period he should attend night classes, and so keep up his mathematics. Whenever possible, every opportunity should be taken of seeing machines and engines in motion and inquiries should be made as to the up-keep. Finding the best way to facilitate matters for the man that has to attend to the job always gives place for a little more thought. Just before the end of his apprenticeship he should sit for his matriculation. After passing, he should go to a good college and study for his B. Sc.; his summer vacation should be spent in the drawing office of a large engineering firm, not that he would expect to get the best of work, but to give him an insight into the running and managing of such an office, the reading and marking up of drawings, etc., because drawing office experience is certainly of the utmost importance to all engineers.

If such a course of training and educating was carried out, I am sure there would be little fear about securing adequate men to fill the places of the retiring "Old School."

James Carnegie, Jr.

Loss of Vacuum in Dredging Pumps

A partial loss of vacuum in one of the main pumps on a large dredger in which I did duty as first assistant engineer, gave us on one occasion a fair measure of food for thought, as well as much unnecessary hammer and chisel work, before we discovered the cause, simple enough though it proved to be in the end.

The pump in question had a 7-foot impeller, and was driven by a triple-expansion engine capable of developing 1,500 horsepower. Under ordinary working conditions our gages indicated 27 to 28 inches of vacuum, but at the time of which I write a gradual decrease in the vacuum indicated on our port pump became noticeable. We tested our gage, examined the impeller and its portable throat piece, and, of course, made sure that no leakage of air was taking place at the impeller shaft glands or suction pipe joints; but our gage was found correct, the pump in perfect working order, and all glands, etc., quite air-tight.

With regard to leakage of air into a suction pipe, and the effect of such leakage on a well-designed centrifugal pump, it may be interesting to note the result of an experiment made while we were busy trying to solve the problem set us by our port pump. In the suction pipe, and at a short distance from the impeller casing, we drilled a hole 1 inch in diameter, fitted a wooden plug into this hole and started our pump. When the vacuum had reached its apparent limit the plug was withdrawn, but though the inrush of air was very considerable the effect was scarcely, if at all, noticeable on the vacuum gage. From this we inferred that the efficiency of our centrifugal pumps could not be seriously impaired by a leakage of air in such a volume as might seriously affect the working of an ordinary pump.

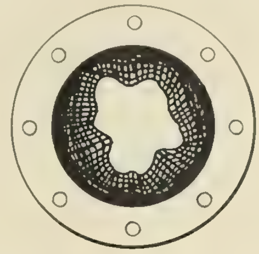
The cause of our perplexity was still to be found, however, but find it we did; and not in the suction but on the discharge side of our equipment, and in the flexible sleeve whereby connection was made to the floating pipe line which conveyed our spoil to the shallows over which it was distributed. The sleeve in question was made of stout leather, double-ply, held together by copper rivets, and protected on the outside by a kind of chain mail covering. When, in the course of a diligent search for several missing inches of vacuum this sleeve was disconnected, its inside presented the curious picture shown in the sketch. The inner ply of leather was worn away at places where it had probably been kinked, and the opening thus made had formed the mouth of a concentric bag, so to speak, which, filling up with mud and sand, reduced the actual area of discharge to such an extent that "throttling" took place, with the result that a back pressure was formed in the impeller casing, with a corresponding loss of pumping power, of which the first indication was given by our vacuum gage.

In this case the remedy for the difficulty was, of course, the fitting of a new sleeve.

When next I saw a similar problem present itself for solution it was on another hydraulic dredger of the hopper and overboard discharge type—that is to say, we could fill our hoppers and pump the contents on shore, or dump them through the bottom; or we could dredge and discharge the spoil direct into a floating pipe line, or across a levee, without putting any into our hoppers.

On this occasion the loss of vacuum again indicated a block in the discharge pipes; the block being caused by the *debris* (bits of rope, old matting, and many of the curious odds and ends to be found at the bottom of one of the busiest river ports in China) which from time to time fouled the isolating valves in the discharge pipes leading to the hoppers. These valves were of the "butterfly" type, and the difficulty was this time overcome by their removal altogether, ordinary flap valves with suitable closing gear being fitted instead to the ends of the discharge pipes where they led into the hoppers.

I may say that in the second instance referred to the vacuum gages were fitted on the air chambers with which our suction pipes were provided. In the first instance mentioned the gages were fitted to the impeller casing, and there were no air chambers on the suction pipes.



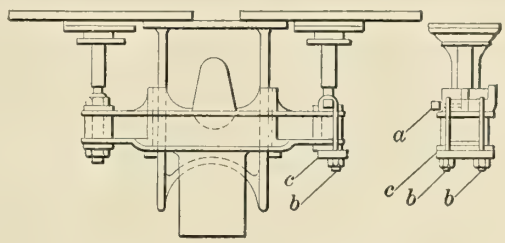
EXTENT OF ACCUMULATION IN SLEEVE

Mark Nesbit.

Repairing a Broken Valve Stem

A broken valve stem would seem like rather a serious thing to most of us and it would be likely to interrupt things for a while. It is a little out of the ordinary therefore to have one snap and be under way again in thirty minutes.

At 10:30 one morning our outboard A. L. P. valve stem broke just at the top of the yoke. The engine was stopped; a dog brought from the machine shop and secured to the broken stem with a set screw in dog (*a*) after cutting a place in the stem for the end of the set screw. While this was going on two bolts (*b*) were having hook ends bent on them in the fire-room, and a strap (*c*) was drilled to go on the bottom of the yoke through which the bolts were to go. The other ends of the bolts were to go over the dog, one at the set-screw end and the other at the tail end, as shown in the sketch.



REPAIRS TO BROKEN VALVE STEM

In just thirty minutes from the time of the break we were going ahead again, and for several days the arrangement held until we reached port and replaced the broken valve stem with a new one.

Reader.

Freight Train Collides with Steamboat

An extraordinary event was recorded recently in the St. Louis newspapers, in which a railway train collided with a steamboat, both the train and the steamer remaining on their natural element. The collision took place during the floods that devastated the Ohio Valley during the early spring. The small steamer *Lochie S.*, in proceeding up the Ohio Valley along the Cumberland River, then at its greatest flood height (covering the low lands and submerging the tracks of the Louisville & Nashville Railroad), made her way far from the usual river channel and crossed the railroad tracks just in time to meet a freight train, when, owing to darkness and a misunderstanding of signals, the railroad locomotive plowed into the starboard side of the steamer, temporarily suspending traffic at that point.

H. M. Baker.

St. Louis, Mo.

Marine Articles in the Engineering Press

Steam Trials of H. M. Battle-Cruiser Queen Mary.—Built by Palmer's Shipbuilding & Iron Company, at Jarrow-on-Tyne, and engined by Messrs. John Brown & Company, Ltd., of Clydebank, the battle cruiser *Queen Mary,* which is 660 feet long, 89 feet beam, with a displacement of 27,000 tons at a draft of 28 feet, showed most satisfactory results in the various trials which were carried out recently. The main engines comprise a four-shaft arrangement of Parsons turbines, designed to develop 75,000 horsepower, a figure which was exceeded by 10 percent on trial. 350 words.—*Engineering,* June 6.

H. M. Torpedo-Boat Destroyers Shark, Sparrowhawk and *Spitfire.*—These vessels form a group of three of the twenty British destroyers designed by Sir Phillip Watts, K. C. B., when director of naval construction at the Admiralty and built in various establishments under the 1911-12 programme. The hulls of these three vessels were constructed by Messrs. Swan, Hunter & Wigham Richardson, Ltd., and the propelling machinery by the Wallsend Slipway & Engineering Company, Ltd., Wallsend-on-Tyne. The vessels are 260 feet long, 27 feet beam, 9 feet 4 inches draft, with a displacement of 935 tons, of which the hull weights comprise 373 tons. Designed to steam at full speed in a heavy sea, they are provided with an exceptionally high forecastle, the conning tower and bridge being located directly behind the after end of the forecastle. The armament includes three 4-inch guns and two torpedo launching tubes, one amidships and one aft. The propelling machinery consists of a twin screw arrangement of Parsons turbines, each turbine having ahead-going and astern sections incorporated in the same casing. An impulse wheel with special blading is fitted to both the ahead and astern turbines to deal with the highest pressure steam which is admitted through groups of nozzles, each group having a controlling valve. After leaving the impulse wheels the steam is further expanded through a number of stages fitted with the usual reaction blading of the Parsons type. The engines of each destroyer were designed to develop 24,500 shaft horsepower in order to give a speed of 29 knots. On trial all of the three vessels on the six runs over the measured mile, made in rough weather in each case, attained a speed of about 30¾ knots, with an average mean shaft horsepower of about 25,400 at 635 revolutions. This power was maintained for eight hours in all three vessels, with an oil consumption of about 1 pound per shaft horsepower per hour. Details of the boilers and auxiliaries are included in the article. Two illustrations. 1,000 words.—*Engineering,* June 6.

Misconceptions of Propeller Action.—In an editorial discussion, pointing out a number of erroneous assumptions which form the basis for many of the proposals which are so frequently made by theorists in attempts to improve the efficiency of the screw propeller, the conclusion is reached that a screw propeller having a driving face of truly helical shape, a symmetrical section of blade, a diameter and area of blades correctly apportioned to the work to be done and a boss as small as possible, will be the most efficient instrument for screw propulsion. Among the fallacies discussed were the following: That the blade surface of a propeller should have a progressively increasing pitch in the axial direction from the leading to the following edge instead of having a truly helical shape; that a gain in efficiency can be obtained by propellers with blades having a section which has both the driving face and the back of the blade curved, so that the metal shall be symmetrically disposed on each side of the line joining the following and leading edges, which line will then be the real pitch line of the propeller; that centrifugal action at the propeller causes water to be thrown off radially at the tips, thus dispersing it in other directions than the sternward one desired and absorbing energy which is lost as propelling force; that water near the center of a propeller does not contribute adequately to thrust because of a churning action at the root of the blade, and also that some other shape of blade section than that most commonly adopted would reduce the resistance of the propeller to rotation. While these fallacies are pointed out, it is also conceded that it is possible that a gain could be effected if the propeller were divided transversely into two parts—one right-handed and the other left-handed—turning in opposite directions as in torpedoes, so that the spiral action imparted to the water by the forward half would be neutralized by that from the after portion, and the momentum would be imparted to the water in a more directly sternward direction than is now possible. This, however, for the most part, has proved impractical, as it involves concentric shafting revolving in opposite directions. 1,600 words.—*The Engineer,* May 30.

An Armored and Semi-Submersible Destroyer.—By Hector C. Bywater and Maurice Prendergast. In the November, 1911, issue of the *Morskoi Sbornik,* the leading Russian naval review, there was published a design and a description of a proposed torpedo boat destroyer which had certain novel features. This article gives the main particulars of this design and comments upon the feasibility of such a type of vessel. The main feature of this design is the provision of armored protection on the destroyer strong enough to enable the vessel to withstand the attack of quick-firing guns up to 6-inch caliber. The only armor used on the destroyer is a protective deck, which covers the vital parts of the hull and extends 7 inches below the load waterline. To eliminate the danger of shells striking beneath the armor, provision is made for submerging the boat 19¾ inches deeper than the normal load waterline before going into action. In the design suggested the boat is 243 feet long, 28 feet beam, 6.2 feet draft, 620 tons displacement, with engines of 11,000 horsepower, designed to give a speed of 30 knots. In order to submerge the boat 19¾ inches, 225 tons of ballast are necessary, and this is provided by flooding certain of the watertight compartments. The deck armor is 2½ inches thick where it slopes to the waterline, and the boat is armed with eight submerged torpedo tubes, two 4.7-inch quick-firing guns and four machine guns. The design is criticised by the authors of the article in that it does not suggest either habitability or seaworthiness, and that the power seems inadequate for the expected speed. It is admitted, however, that the conception presents a wide field of possible development, as the application of armor to high-speed ships is a feature that will become general at no very distant date. 5 illustrations. 3,100 words.—*The Shipbuilder,* June.

The John Samuel White Diesel Engine.—John Samuel White & Company, Ltd., the well-known destroyer builders, of Cowes, I. W., have now built some half dozen Diesel engines under license from the M. A. N. This firm has adopted the two-cycle M. A. N. engine, and the details of their product apparently differ little from the original M. A. N. engine. The article gives a detailed description of the construction and operation of this engine, citing the trials with a 150-horsepower engine as an example. 3 illustrations. 5,500 words.—*The Engineer,* June 6.

Resistance of Submarines when Submerged.—The factors which affect the submerged resistance at any speed of a particular submarine, the general hull proportions of which are fixed, may be broadly summed up in three groups—surface friction, depth of submersion and number and form of appendages. Surface friction resistance depends wholly upon the superficial area of the vessel for any particular speed, and is not affected in any way by change in the depth of submersion. With the same submarine run at different depths eddy-making will also be practically constant, so all the change of resistance which is measured may be attributed to variation of wave-making resistance with variation of submersion. Reference is made to the paper read at Rome before the first National Congress of Engineers by Capt. Leonardo Fea, describing experiments made on submarine models at Spezia, which give valuable information on the second and third factors considered. 1,400 words.—*The Engineer,* May 16.

The Passenger and Cargo Steamer Digby.—Messrs. Irvings' Shipbuilding & Dry Docks Company, Ltd., West Hartlepool, has built to the order of Messrs. Furness, Withy & Company, Ltd., the single screw passenger and cargo steamer *Digby,* designed for the owners' passenger, fruit and general cargo trade between Halifax, N. S., and Liverpool or London. The vessel is 365 feet long, 350 feet between perpendiculars, 50 feet extreme breadth, 25 feet 6 inches molded depth to upper deck. The hull is provided with a cellular double bottom, and is further subdivided by six transverse bulkheads. An elaborate system of mechanical ventilation has been fitted to the holds and 'tween decks throughout. Accommodations are provided for fifty-eight first class and thirty-two second class passengers. The propelling machinery, supplied by Messrs. Richardsons, Westgarth & Company, Ltd., of Hartlepool, consists of a set of triple expansion reciprocating engines with cylinders 28 inches, 46 inches and 77 inches diameter by 48 inches stroke. Steam is supplied by three single-ended boilers, each 16 feet 6 inches diameter by 12 feet long, working at 180 pounds pressure under Howden's forced draft. The designed speed is 12½ knots and the mean trial speed for four runs on the measured mile was 14.38 knots. 5 illustrations. 1,150 words.—*The Shipbuilder,* June.

The New York Pier Problem.—An elaborate series of towing experiments was carried out by Naval Constructor D. W. Taylor in the experimental tank at the navy yard, Washington, to study the problems involved by the various proposed pier encroachments on the shore lines of the Hudson River, where practically all of the large transatlantic express steamers are now berthed. The tank was arranged to simulate upon a proper scale a section of the river in question with its flanking piers, and models of the craft which ply in these waters were towed under various conditions to determine the suction effect exerted upon vessels moored at flanking piers when a large liner approaches or leaves a dock in a strong tideway, as well as the influences upon nearby shipping in motion. In the trials the model ocean steamship was progressively towed closer and closer to the pier heads and at varying speeds, duplicating the circumstances of slack tide and the conditions of ebb and flood at full swing. While the results from these experiments have not as yet been disclosed, it is intimated that these experiments confirm the earlier researches upon suction between ships made by Naval Constructor Taylor a few years ago, and they also clearly demonstrate that the size and draft of great liners materially effect the measure of the disturbances aroused, and these must be given their proper weight in considering the dock problem of any port where the waters are confined and where tidal velocities are of importance. 2 illustrations. 3,250 words.—*The Engineer,* May 16.

H. M. S. King George V.—The *King George V* and her three sister ships *Ajax, Audacious* and *Centurion,* all of the *Orion* class, represent a distinct advance over their predecessors. *King George V* is 555 feet long, 89 feet beam, 27 feet 6 inches draft with a corresponding displacement of 23,600 tons, or 1,100 tons more than the *Orion.* Propulsion is by Parsons turbines of 31,000 horsepower, supplied with steam from Babcock & Wilcox boilers. The normal fuel supply is 900 tons, and the maximum, with an additional supply of oil, 2,700 tons. The designed speed is 21 knots. The main armament consists of ten 13.5-inch guns, arranged in five turrets on the center line of the ship, using projectiles of 1,400 pounds. The secondary battery, which consists of sixteen 4-inch guns, is severely criticised in this article as being inadequate for repelling torpedo attack. *King George V* is protected amidships for about 250 feet by 11 to 12-inch armor, reduced to 7¾ inches below the end turrets and tapering to 4 inches fore and aft, leaving a space of about 30 feet unprotected at the bow and stern. Above the main belt is a strake of 9¾-inch armor, which extends from the base of the first turret to the base of the aftermost turret. 1 illustration. 930 words.—*The Marine Engineer and Naval Architect,* June, 1913.

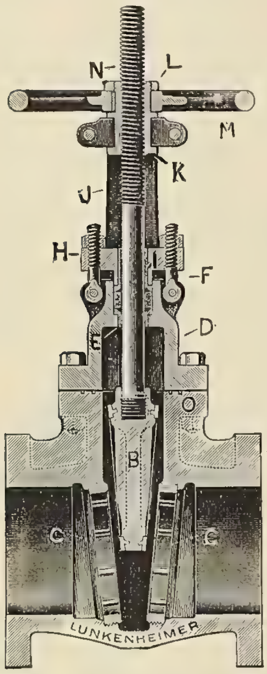
Steam Trials of H. M. S. Ajax.—On the trials of the battleship *Ajax,* with the turbines running at an average of 289 revolutions, the shaft horsepower was 19,830 and the consumption of coal 1.79 pounds. On the eight hour full power trial the average revolutions of the four shafts were 330, the total shaft horsepower just over 28,000, the average speed over 21 knots, and the coal consumption 1.69 pounds per shaft horsepower per hour. 500 words.—*Engineering,* May 30.

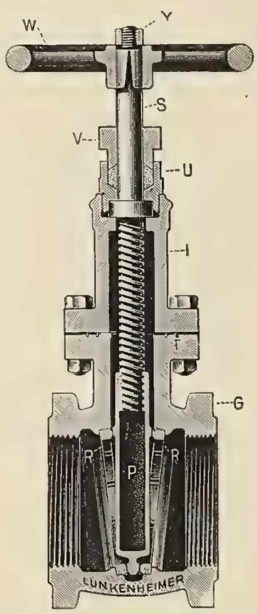
The Yarrow Boiler.—Tests were made recently on an improved Yarrow boiler having 4,440 square feet of heating surface, 93.9 square feet of grate area and a combustion space of 610 cubic feet capacity, which is similar to the boilers constructed for the Chilian battleship *Almirante Latorre,* now being built at the Elswick Works of Sir W. G. Armstrong, Whitworth & Company, Ltd. One of the improvements in the boiler consisted in placing angle-iron baffles on the outside rows of tubes to equalize the volume of the furnace gases passing through the nest of tubes, and to equalize the temperature of the gases as they pass the last row of tubes of the tube nest, thereby securing a high efficiency. Another improvement consisted in modifying the original feed water heater used in this type of boiler. The original feed heater was constructed by dividing off a certain number of the outer rows of tubes by partitions in the water pockets and passing the feed into the space thus divided off, so that the feed water would pass up through the two or three rows of tubes furthest from the furnace before it mixed with the general circulation of the boiler. This method of feed heating has been found to result in an economy of from 5 to 7 percent, but a further improvement was introduced by fitting a longitudinal plate on each side of the steam chest, so as to partition off the feed heating tubes where the feed enters the steam chest, in order to prevent the cooler feed water from rushing down the adjoining rows of tubes and alternately cooling and heating the plates and joints of the water pockets, and thereby producing excessive strains and causing serious leakage with a risk of cracking the plates. From the tests made it was shown that the gain by adopting the Yarrow system of feed heating was an increase in evaporation per pound of oil of 6 percent and a reduction in the temperature of the gases of 24 percent. The figures show that higher evaporation is possible with oil fuel as compared with coal, and the great advantage of the baffling arrangement as well as of the use of the outer tubes for heating the feed. Having in view the evaporation obtained with the most recent type of Yarrow boiler in combination with the latest type of turbine, the conclusion is reached that one shaft horsepower can be obtained from .9 pound of oil fuel, and if superheating be adopted a gain of 10 percent for every 100 degrees F., is secured. From experiments made by Messrs. Yarrow, this amount of superheat is easily obtainable in marine practice, and it is not unreasonable to expect that with 200 degrees F. of superheat it will be possible to obtain one shaft horsepower from 7½ pounds of oil fuel under naval conditions. 2 illustrations. 1,500 words.—*Engineering,* May 15.

ENGINEERING SPECIALTIES

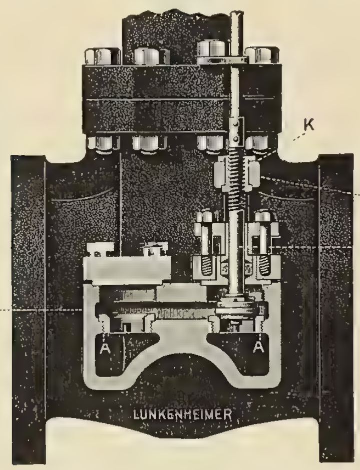
An Improved Gate Valve

The improved gate valve illustrated herewith, which is manufactured by the Lunkenheimer Company, Cincinnati, Ohio, is made either entirely of brass or iron body, brass mounted, or in "puddled" semi-steel, and also cast steel. It is also made in practically all sizes and patterns and for all pres-





sures and temperatures for which such valves are necessary. As can be seen from the illustrations the valves are made in two forms, one with a stationary stem and the other with outside screw and yoke. The seat rings, as well as the wedge disk, can be removed when worn, thus making the valve as



good as new. A very desirable feature in the construction of the valves is the fact that when finishing the interior of the valve body, that portion which receives the seat rings is threaded to the correct angle of the tapers of the valve disk. The seat rings are threaded and faced off straight, and when screwed in place they fit accurately to the tapers of the disk. This consequently makes it possible to easily renew the seat rings when they become worn or broken, hence prolonging the life of the valve. As the valves are double-seated they will take pressure from either side. Either pattern of the gate valve can be packed under pressure when wide open. The stuffing-box in the valve with stationary stem is made of bronze and is tightly screwed into the hub. In the valves with outside screw and yoke, both the gland and stuffing-box are lined with bronze bushings, which form a perfect bearing surface for the stems. The disks are accurately guided in the bodies, and by means of the guides the stems are relieved of all side strains. It is claimed that the valves are not affected to any extent by expansion or contraction. The joint between the body and hub is worthy of attention, for the reason that it is practically indestructible. It consists of grooves cut in the top surface of the valve body, in which are placed seamless copper gaskets. A joint made in this manner, it is claimed, will never leak and cannot wear out.

The valve can also be had with an exterior by-pass, a detailed view of which is also shown herewith. The by-pass used on the Lunkenheimer "Victor" valves is not separate from the valve proper but is cast integral with the body. The additional metal required for the by-pass tends to strengthen the valve body, and being self-contained it is not affected by extremes of expansion or contraction. The stuffing-box is made of bronze, and has a flange on the bottom, which prevents the iron flange above it from touching the iron body, and hence prevents the corrosion between these surfaces. Referring to the illustration, the outside screw and yoke *H* increases the durability of the thread on the stem *J*, owing to the fact that they do not come in contact with steam. The bushing *K*, which is threaded to receive the threads of the stem *J*, not only prevents corrosion but also makes it possible to renew the same should the threads become worn. The areas of the by-passes of these valves are sufficiently large to admit enough steam around the disk to quickly equalize the pressure on both sides.

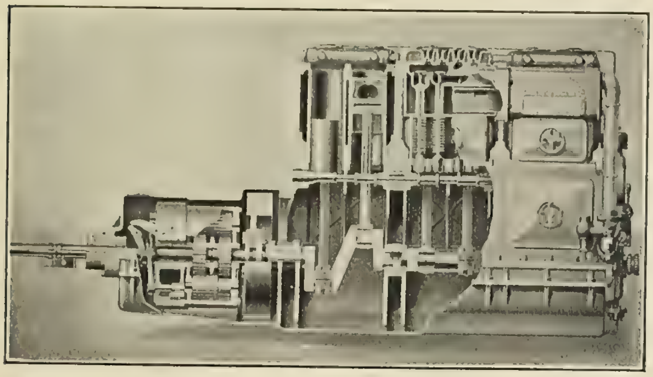
Winton Marine Engines

The Winton Gas Engine & Manufacturing Company, Cleveland, Ohio, has recently placed on the market an internal-combustion engine, known as the Winton Six Marine Engine, designed for all classes of marine service, such as high-class yachts, towboats and commercial motor boats. In the design of these engines all manifolds, piping and fittings that are usually found on marine motors have been eliminated and all the working parts have been enclosed, yet in such a way that they can be inspected immediately. The flywheel is removed from the front of the motor and housed at the after end, where it absorbs the strain from the propeller and shafting. The position of this wheel also eliminates the element of danger to the operator. Ample proportions of the working parts, together with the weight of the motor located where it should be to take the jar and explosive strains, it is claimed, eliminate vibration.

Chrome vanadium steel, heat treated and of ample proportions, is found in all the working parts which are subject to heavy working strains. The cylinders and pistons are of the very best close grained cast iron obtainable, heat treated, and even the small gears and pinions are hardened and tempered in oil and are of a high grade steel. There is not a single cast iron gear in the whole machine. The cylinders, pistons, cam shafts and all other bearing surfaces are ground by special machinery, constructed for the purpose. The connecting rods are drop forgings of .35 to .40 carbon steel, heat treated. The piston end is provided with a tool steel wristpin, which actuates on phosphor bronze bushings in the piston. The crankshaft end is machined to receive a die-cast bushing of white brass. The crankshaft and connecting rod bearings are of Parsons white brass and all others of phosphor bronze.

Oil is carried in the engine base and distributed under pressure by a geared pump to every working part and afterwards filtered for use again. Ignition is by the Bosch low tension system, using magnetic make-and-break plugs. Reversing is obtained by special spur gearing of Winton design. Both gears and shafts are of integral forgings of chrome vanadium steel, heat treated.

One feature of this engine, which contributes to the steadiness of construction and does away with the piping and gear usually so prominent in marine engines, is the arrangement of the water, fuel and exhaust manifolds, which are of generous size and are integral with the cylinder castings. The cam shaft drive is obtained by a vertical jack shaft through worm spirals, which it is claimed gives a silent drive. The valve action is entirely housed and absolutely quiet. This is an exclusive feature of the Winton marine engine, which is



obtained through special cam millers designed and built by the manufacturers for this particular purpose. A centrifugal pump driven from the crankshaft with independent connections in the cylinder heads, with valves for regulating the volume, provides the water circulation. Control is obtained by a centrifugal governor operating at a constant mixture, volume throttling principle, so that any speed may be had by adjustment of this governor control.

Six cylinder engines rated at 60 to 75 horsepower, with cylinders 6½ inches diameter by 9 inches stroke, operating at 400 to 500 revolutions per minute, weigh 5,000 pounds, while six cylinder engines of 150 to 200 horsepower, with cylinders 9 inches in diameter by 14 inches stroke, operating at 350 to 425 revolutions per minute, weigh 1,500 pounds.

An Improved Process for Making Corrugated Tubes

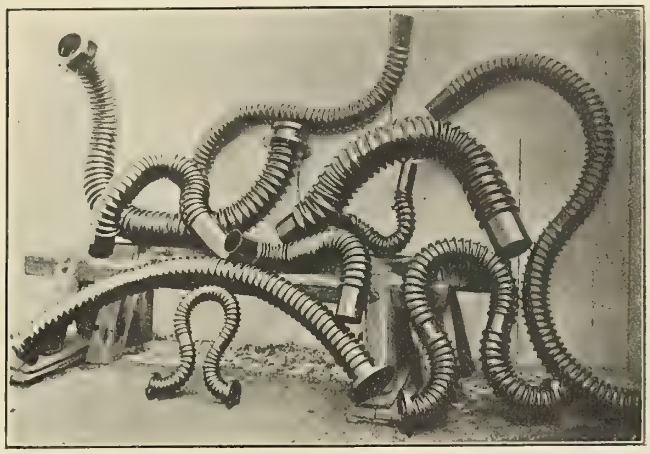
The term corrugated tubes is not new. Under this name tubes manufactured by various methods have been brought out from time to time with more or less success. Recently a process of manufacture has been patented which, on account of the excellent results secured, has been adopted for many purposes. The process has been patented in the United States and Europe by Mr. W. Maciejewski, a Polish engineer. The European patents have already been purchased and corrugated tubes made according to them by the following companies: Russia, "Compensator" Works, W. Maciejewski, Warsaw, Polna 36; Germany, Franz Seiffert & Company, Act. Ges., Berlin, SO 33; Belgium, Anciens Etablissements Louis De Naeyer, Société Anonyme, Willebroeck; France, La Compagnie des Forges D'Audincourt. The United States patents are offered for sale by Schuchardt & Schutte, of 90 West street, New York.

Either standard wrought iron or steel tubes can be corrugated by the Maciejewski process. According to the pressure and size required, small and medium-size tubes are made from ordinary steel tubing, while for large diameters lap-welded and rerolled tubes are used. The corrugations are made by an ingenious method of pressing the material together, a special machine being employed, the design and construction of which are fully covered by patents. An important feature in the present process and not found in any other is that, through shortening the tubes, the corrugations are pressed into them at equal distances apart without decreasing the original inside diameter. Furthermore, the thickness, it is claimed, remains absolutely uniform, and is the same as in the original tube. During the process of corrugating any defects in the material at once become apparent.

Interesting examples of corrugated tubes are shown in the illustration. They can be made in all sizes, from 1⅜ inches up to 18 inches, including diameters suitable for use in boilers. Here the average length is about 12 feet, although any other length can be manufactured if required. The tubes for very long lines can be partly corrugated.

Of the many different uses to which Maciejewski's tubes can be employed to advantage the following should be particularly noted: In steam pipe lines the contraction and expansion caused by the steam, and vibrations of the engines, pumps and other units are effectively taken care of by the elastic property of the tubes. Also in firetube boilers a greater heating surface is secured, and the strain is removed to a large extent from the head plate and the combustion chamber. In superheaters the heating surface is increased, and the same is true in radiators for steam and for hot water heating systems. The greatest advantage of all is the use where the space for expansion and contraction is limited and large bends cannot be made, as is the case on steamships.

When steam is turned on or off there is a wide variation in the temperature, hence there is considerable linear movement in the line and its branches to the various units. This movement was taken up by U bends prior to 1890, and later on by expansion joints. Both, however, have their disadvantages, and have been replaced in many large installations in Europe by a length of pipe corrugated by the Maciejewski's process. Tests made by the Association of German Engineers have shown that smooth tubes when bent have a greater elasticity than they should have according to theoretical calculations. The reason for this is that during the process of bending small corrugations are made, which increase the elasticity when expanding and contracting. Thus, when the small corrugations are increased to a height of ten times the thickness of the material the flexibility of the tube is also increased, the corrugations in the throat being pressed together, while those on the periphery are pulled apart. On account of the easy bending properties of corrugated tubes very small radii can be readily obtained having a large amount of elasticity. For instance, a smooth pipe 10 inches in diameter, having a height of 108 inches and an 108-inch throat, has a maximum expansion of 2 inches. A corrugated tube of the same diameter, but only 63 inches high and a 55-inch throat, has an expansion of 5½ inches. Hence a pipe line which has an expansion of 5½ inches would require three bends of smooth pipe with a combined length of about 81 feet, or only one corrugated tube 12 feet long. The advantage in favor of the latter is at once apparent.



Fire Extinguishing and Fumigation by the Harker Process

The Schutte & Köerting Company, Philadelphia, Pa., has acquired the rights to manufacture in the United States the apparatus now known as Harker's fire extinguishing and fumigation apparatus, which makes use of the products of combustion for fire extinguishing and fumigation. With this apparatus connection is made with the boiler smokestack, from which the gases are drawn to the machine, where they are washed and cooled before passing into the compartments to be fumigated, or before being used for fire extinguishing purposes.

Atmospheric air contains about 21 percent of oxygen. Should this oxygen be reduced by about 25 percent to, say, 15 percent of the air, the combustion of all ordinary material

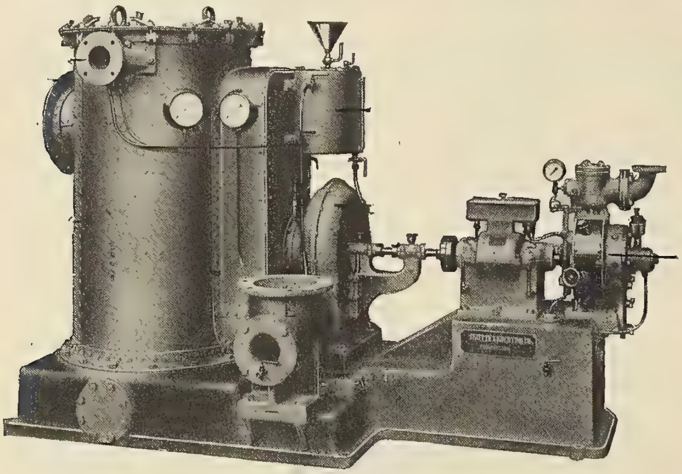


FIG. 1

must cease. It is upon this important fact that the Harker apparatus depends for its ability to put out fire. In burning coal or other fuel in a boiler a considerable portion of the oxygen combines with the fuel; the resulting product of free gas contains about 9 percent of oxygen, and there is, therefore, not sufficient oxygen in this gas to sustain combustion. Therefore, should a fire break out in a ship's hold or other compartment, the compartment may be rapidly filled with the cooled and washed gases, when the fire will be rapidly extinguished. By continuing to force the cooled gas into the compartment the residual heat will soon be carried off, reducing the whole to a normal temperature.

Fig. 1 shows a machine of this type fitted on the steamship *Fiona* and an the American marine tender *Bratton*. Figs. 2 and 3 show the *Fiona* in profile, and indicate diagrammatically the pipe runs for carrying the gases to the various holds. Branches are also led up on deck, terminating in couplings to which flexible hose may be connected, thus enabling the gas to be carried into the various quarters should occasion arise.

The installation on the *Bratton* is used to fumigate all vessels entering the port of Philadelphia. The *Bratton* is run alongside the vessel to be fumigated; flexible hose is carried into the holds, thereby filling them with the gas.

As fitted on these two vessels the apparatus consists of a De Laval steam turbine-driven blower, gas washer and cooler, and an in-take or suction two-way damper. This damper is so arranged that either flue gas or fresh air may be drawn into the machine.

Fig. 4 shows the general arrangement of the latest design of the apparatus, and Fig. 5 shows the same arrangement partly in section in order to illustrate the spray nozzle action. The two-way butterfly valve *V* is arranged with a fresh air in-take *F*, which is screened to prevent papers, etc., from being drawn into the machine. The opening *S* is connected to the smokestack. The gases are drawn from the smokestack through this damper into the cooler *C*, which is divided into a number of chambers, each chamber having a series of spray nozzles, as shown in section, from which water is sprayed in the same direction as the air is traveling. The gases, after being sprayed in four chambers, pass up through the fifth chamber *H*, in which no water is sprayed. They then are carried through the moisture eliminator *E*, which removes any entrained moisture. From thence the gases are delivered to the suction of the turbine-driven blower *B*, and discharged to the various hose connections. The water from the sprays, and also from the moisture eliminator, drains into the base of the washer and is carried overboard through the outlet *O*. In Fig. 4 is shown the disinfector tank, which is arranged in two sections, the upper section being merely a container having a gage glass arranged to show the amount of formaldehyde contained. The lower section is arranged with a pressure gage and safety valve, and inside is a steam copper coil, so that the contents of the tank may be heated and the formalyn driven off under pressure through the pipe *P* into the fan discharge. The lower section of the tank *D* can also be drained to the base. The various spray nozzles are arranged to give a maximum cooling effect. They are connected up to an outside pipe line which takes its supply of water under pressure from a pump.

When operating under good working conditions, burning coal in the boiler, each ton produces about 450,000 cubic feet of free gas. It will be seen, therefore, that an almost unlimited supply of gas is available for fire extinguishing purposes and at little or no cost, as the flue gases are entirely waste product. If fire is found to have broken out the machine can be started up and the boiler fires kept fairly thick and well supplied with coal. If there are any air dampers, such as in the Howden system, permitting air to enter the top of the furnace, these dampers should be closed so that as large a quantity as possible of oxygen in the air may be combined with the coal in combustion.

Flue gases from oil firing are equally effective, as is also the exhaust from internal combustion engines. This latter is very effective, as the quantity of oxygen contained in the gas is exceedingly small.

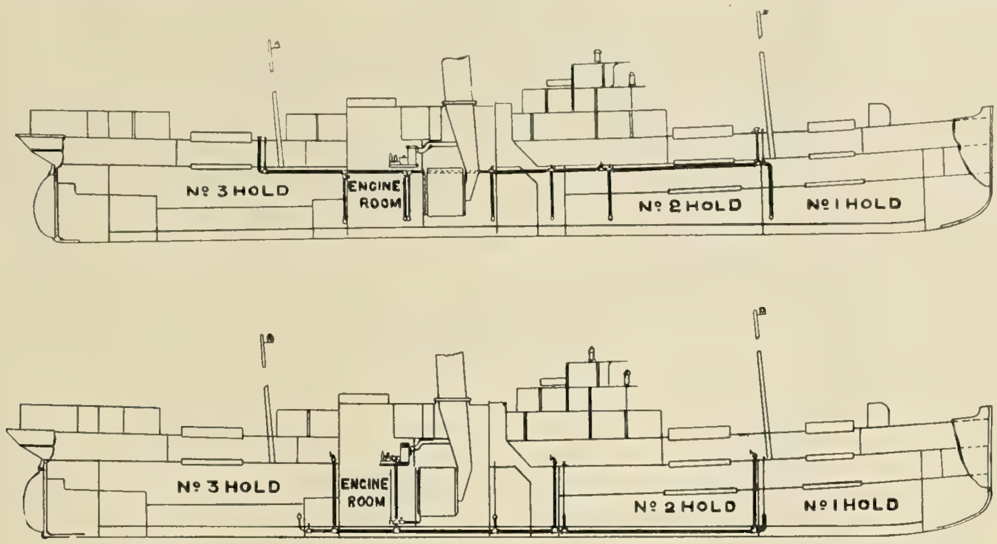
The Harker system has been objected to on the grounds that the gas might contain carbon monoxide in such quantities as to form an explosive mixture with the air in the hold. To this objection rejoinder is made that if such a liability to explode exists, it ought to show itself when a fireman opens the door of a boiler furnace, allowing a rush of air to mix with the supposed inflammable gas. It is common knowledge, of course, that such an event never happens. Further, by experiment it has been shown that not less than 16 percent of the carbon monoxide must be present with the mixture in the air before explosion is possible, and experiment shows the proportion of flue gas runs generally about 1.5 percent, and has never been known to exceed 5 percent. If the combustion is good it is entirely absent. As a matter of fact, this flue gas is incapable of explosion, as it contains so much inert gas, *i. e.*, nitrogen and carbon dioxide. Further, it has been used to dilute explosive gases, which could then not be exploded.

Dr. Harker, in carrying out fumigation with his system, pumped the flue gases into a large number of steamships; and in order to ascertain if the gases had penetrated the various parts, lamps were used, which were immediately extinguished on coming in contact with the gases.

The system has been investigated thoroughly by a specially appointed naval board, and all the tests have been satisfactorily applied and passed. In one test, carried out at Mare Island navy yard, the flue gases were drawn from the uptake of two boilers burning oil.

A quantity of crude oil was placed in a tank and set on fire. While the oil was burning with great force the machine was started, drawing the gas from the up-take of the boilers through the washers and blowing it into the tank over the burning oil. The flames were instantly extinguished. It was further shown that the gases generated from the hot oil could not be exploded with the flue gas as an atmosphere.

hours, on examination were found to be free from any taint or discoloration. The heat of the gas had melted the butter, but beyond that the butter was in a perfect condition for consumption. The gases are now cooled to such an extent that the possibility of melting such things as butter has been



FIGS. 2 AND 3

As already stated, one of the Harker machines is installed on the United States tender *Bratton*. This machine is in daily use fumigating vessels entering the port of Philadelphia.

The flue gas as it comes from the machine has proven itself of the first order for killing rats, though it will not kill germs or insect life, such as bedbugs and roaches. If, however, a small quantity of formaldehyde or carbon bisulphide is introduced it is claimed that it will kill anything which is to be found alive on board a steamer.

entirely done away with. The fact that these gases have proved absolutely harmless appeals very strongly to ship owners, as the whole ship, including saloons, engine room, staterooms, etc., may be fumigated, no odor being left and no discoloration or damage being done to any of the ship's fabric.

In order to give the gas a distinct odor about ¼ pound of carbon bisulphite, or mustard oil, is added for each 1,000 cubic feet of gas used.

The flexible hose for leading the gas to the holds of the

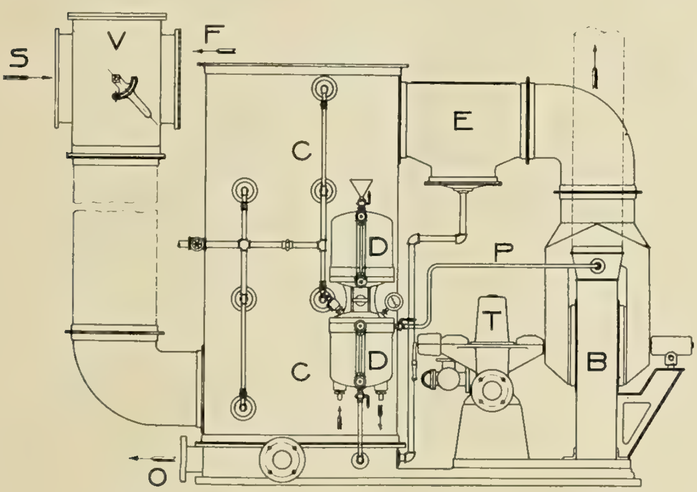


FIG. 4

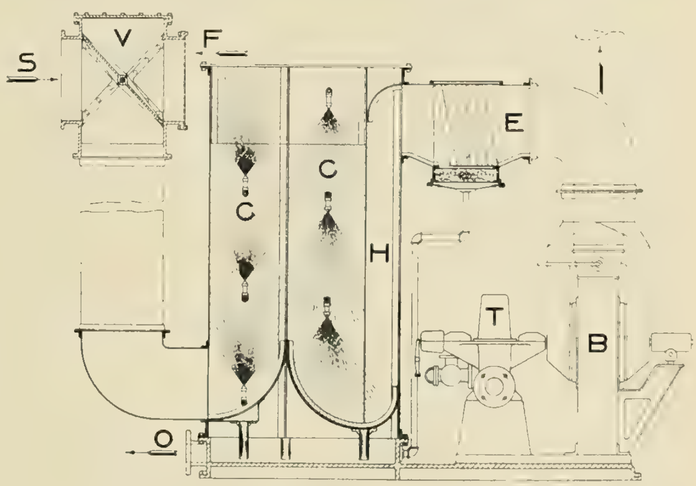


FIG. 5

The *Bratton* is run alongside the vessel to be fumigated, and a flexible hose connected to the discharge of the machine and carried on board the vessel and into the holds to be fumigated. The machine is then started up and the holds filled with gas. The carbon dioxide and nitrogen, of which the gas is principally composed, kills all the rats in a very few minutes, and the formaldehyde, which is introduced through the disinfectant tank, acts as a germicide and raticide.

Extensive tests have been made by bringing the gas into contact with various cargoes. Even such sensitive articles as butter and flour, after having been left in the gases for several

vessels being fumigated is made of spiral phosphor bronze wire covered with canvas. This enables the hose to be easily handled on account of its flexibility and its lightness.

Launch of 700-Ton Hopper Steamer.—Messrs. William Simons & Company, Ltd., Renfrew, launched recently a 700-ton hopper steamer complete with all machinery on board and with steam up ready for trials. This is the first of a fleet of eight dredging vessels this firm has on hand for the naval port Emperor Peter the Great, now under construction at Reval by the Imperial Russian Government for warship purposes.

STATEMENT OF THE OWNERSHIP, MANAGEMENT, CIRCULATION, ETC., of International Marine Engineering, published monthly at New York, required by the act of August 24, 1912.

Editor, Howard H. Brown; managing editor, H. L. Aldrich; business manager, H. L. Aldrich, all of 17 Battery place, New York.
Publisher, Aldrich Publishing Company, a New York Corporation, 17 Battery place, New York.
The stockholders are: H. L. Aldrich, New York; M. G. Aldrich, New York.
Bondholders, A. I. Aldrich, Manville, R. I.; J. W. Reno, New York; George Slate, Summit, N. J.; E. L. Sumner, Flushing, N. Y.

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Sworn to and subscribed before me this 2d day of October, 1912.
(Seal) GEORGE E. MULLER,
Notary Public.
(My commission expires March 30, 1915.)

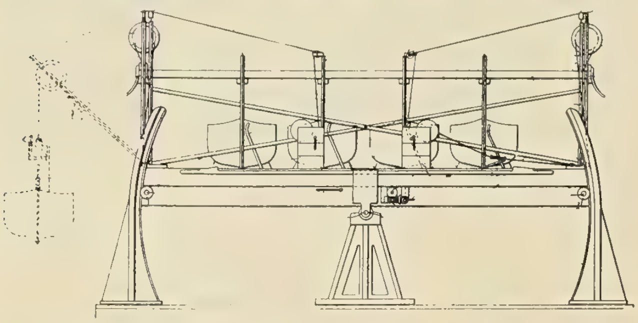
SELECTED MARINE PATENTS

The publication in this column of a patent specification does not necessarily imply editorial commendation.

American patents compiled by Delbert H. Decker, Esq., registered patent attorney, Loan & Trust Building, Washington, D. C.

1,059,148. STOWING AND LOWERING AND RAISING SHIPS' BOATS. WILLIAM JOHN GREENFIELD, OF WATERFORD, IRELAND.

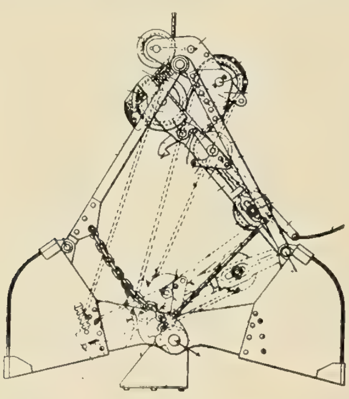
Claim.—An apparatus comprising, in combination, a pivotally-mounted platform disposed athwartship on the deck of a ship and provided with a longitudinal track; means for canting said platform to starboard or port; a traveling cage mounted upon said track for movement theron to



starboard or port when said platform is canted, said cage being adapted to contain a plurality of boats arranged side by side and being provided with rails and trolleys from which said boats are suspended; and tackle for lowering and raising said boats. One claim.

1,062,208. CLAM-SHELL BUCKET. CHARLES S. WILLIAMS, OF CLEVELAND, OHIO.

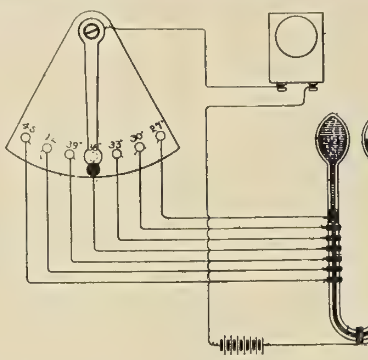
Claim 2.—In a clam-shell bucket, the combination of a frame-member; two oscillatory scoop-members hung from said frame-member; a closing-



member suitably pivoted; means for detachably connecting said closing and scoop-members; sheaves mounted upon said frame-member and closing-member; and a closing-line positively connected with said scoop-members and passing around said sheaves. Seven claims.

1,062,292. AUDIBLE SIGNAL FOR DETERMINING THE TEMPERATURE OF SEA-WATER. ALEXANDER McNAB, OF BRIDGEPORT, CONN., ASSIGNOR TO THE McNAB COMPANY, OF BRIDGEPORT, CONN., A CORPORATION OF CONNECTICUT.

Claim 3.—A water temperature annunciator comprising a receptacle, a heat conducting partition dividing the receptacle into compartments, means for admitting water to one of the compartments, means for discharging water therefrom, an expansible liquid thermometer in the other compartment, a plurality of electricity conducting points in the path of contractile movement of the liquid in the thermometer, an insulated support provided with contacts corresponding in number with the points, circuit connections between the points and contacts, a manually operable

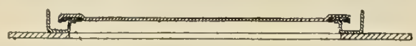


switch carried by the support and adapted for selective engagement with the contacts, a battery, an alarm, and a circuit connection between the thermometer, battery, switch and alarm. Nine claims.

British patents compiled by G. F. Redfern & Company, chartered patent agents and engineers, 15 South street, Finsbury, E. C., and 10 Gray's Inn Place, W. C., London.

5,493. IMPROVEMENTS IN FRAMES PRODUCED FROM SHEET METAL FOR BULKHEAD DOORS AND THE LIKE. MECHAN & SONS, LTD., AND J. YOUNG MOYES, OF SCOTSTOUN IRON WORKS, SCOTSTOUN, GLASGOW.

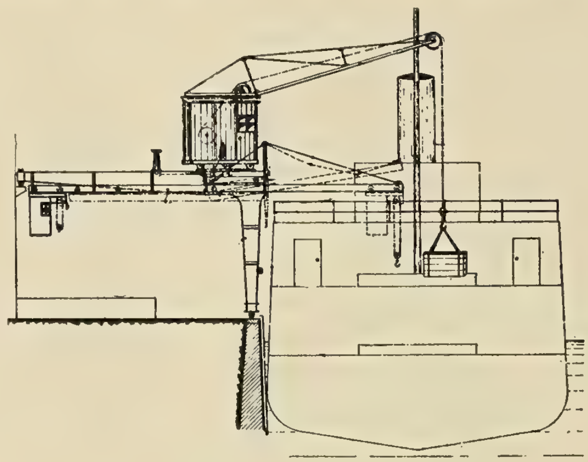
This invention relates to the production of a frame produced from sheet metal for a bulkhead door comprising a body applied to lie against the face of the bulkhead and having around its inner rim a continuous



seating flange for the door to be pressed against, the frame having around its outer rim a continuous stiffening flange extending from the body of the frame and projecting away from the face of the bulkhead. The flanges may be formed with webs, or may be otherwise shaped.

17,349. A LOADING DEVICE ESPECIALLY FOR OPERATION ON HARBORS. DEUTSCHE MASCHINENFABRIK A. G., OF DUISBURG, GERMANY.

Claim.—A loading and discharging apparatus, more especially for use upon wharves for handling ships' cargoes, by which the loads can be raised and moved along a circular or straight path, comprises the com-



bination of an overhead traveler and a slewing crane, the overhead traveler having a movable extension member adapted to be projected beyond the end of the traveller in order to lengthen the track and thus to increase the working range of the crab or hoisting mechanism, the traveler being supported at its end in such manner as to permit the passage of the crab or hoisting mechanism either unloaded or loaded to and from the extension member. The movable extension member of the traveler is adapted for use as the jib of a slewing crane, mounted above the traveler.

5,804. IMPROVEMENTS IN THE CONSTRUCTION OF SHIPS. G. M. HARROWAY, OF PARKSIDE, MIDDLESBROUGH, YORK.

The object of this invention is to so construct ships as to improve their stability. The beam of the ship is increased at about the load line and extends vertically upwards to the free-board deck line and angularly downwards, where it merges into the normal beam of the ship. The cubic capacity of the ship at each side is increased, the additional reserve buoyancy enabling the ship to be loaded to a deeper draft by carrying additional cargo.

International Marine Engineering

Published Monthly by ALDRICH PUBLISHING CO.

17 BATTERY PLACE, NEW YORK — 31 CHRISTOPHER ST., LONDON, E. C.

H. L. Aldrich, President and Treasurer, *Assoc. Member of Council, Soc. N. A. and M. E.*
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Vol. XVIII — AUGUST, 1913 — No. 8

Propelling Machinery for Collier Jupiter

BY WILLIAM L. R. EMMET

The serious development of large high-speed turbines for the generation of electricity began only about twelve years ago and has advanced with a wonderful rapidity. Reciprocating engines have been superseded in most of the important uses to which they were formerly applied. Rates of steam consumption have been greatly reduced and the designs of turbines themselves have been steadily improved and simplified. Th first turbines were of relatively low speed in proportion to their capacity, but the designing of the turbines and of the generators which they drive has steadily advanced the limits of size for a given speed, and this advance has conduced to simplification and great improvement of economy.

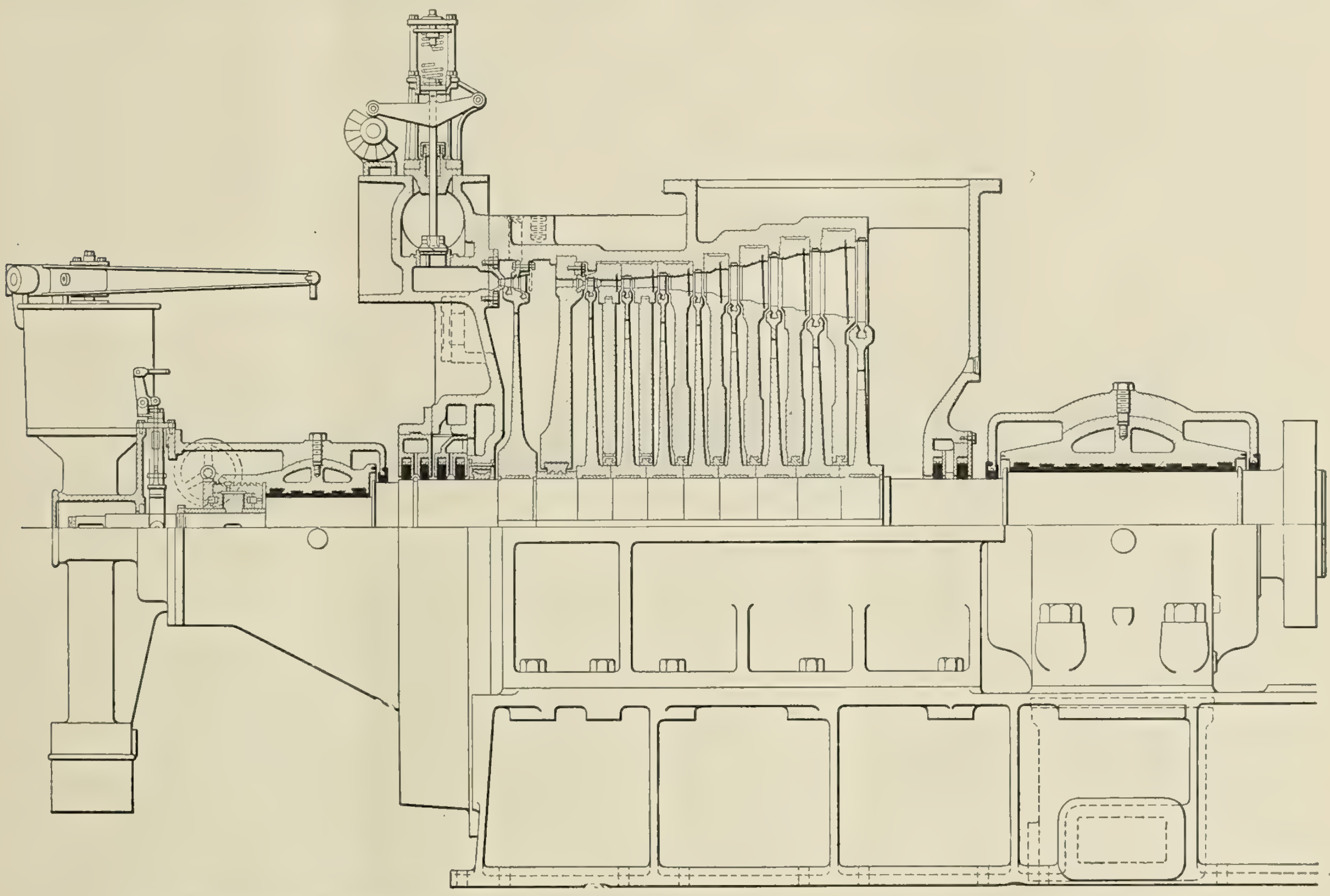

FIG. 1.—ASSEMBLY OF 5,000 KILOWATT HORIZONTAL HIGH PRESSURE 9-STAGE CURTIS TURBINE INSTALLED ON U. S. COLLIER JUPITER

About five years ago the writer became convinced that these improvements of high-speed turbine generating units had attained a degree which justified their use in the propulsion of ships of certain classes—that is, that the superior efficiency and greater simplicity of the turbine were sufficient to offset the expense, weight, and losses incident to the use of electric generators and motors for the transmission of power. The advantages of electric drive are limited by conditions of capacity and of electrical frequency, and are most apparent in vessels requiring very large power and high rates of speed reduction, and particularly such vessels as require variable rates of speed reduction, as in the case of warships, in which it is necessary to make high speed and at the same time desirable to cruise economically at low speed.

Since electric propulsion was first seriously considered, the application of helical gearing to the same purpose has been proposed and successfully introduced on a very considerable scale. While the practical limits of speed reduction gearing are less definitely understood than those of electric transmission, it is the belief of the writer that gears have a very large field of application in the propulsion of ships, and that electricity is preferable only in certain classes of vessels.

The *Jupiter* is one of the new United States Government colliers and is a sister ship to the *Neptune* and *Cyclops.* The

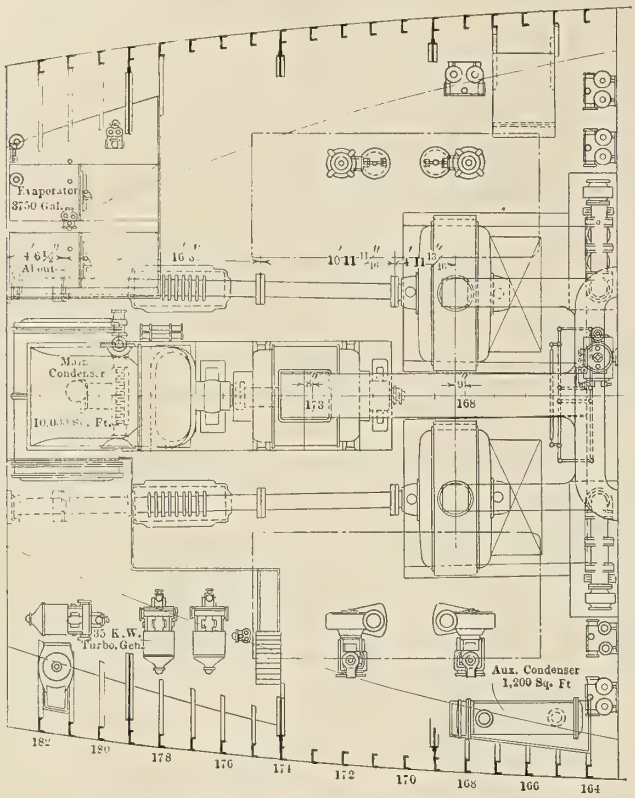

FIG. 2.—PLAN OF MACHINERY SPACE

Cyclops is equipped with reciprocating engines and the *Neptune* with a turbine drive connected to the propellers by gearing. These ships have a displacement of about 20,000 tons and carry something like 12,000 tons cargo. They are designed to operate at 14 knots. The *Cyclops* in her 48-hour trial averaged 14.6 knots, with a coal consumption for the main engines only of 1.485 pounds per indicated horsepower, the total indicated horsepower of both engines in this run being 6,705. The average speed of propellers was 92 revolutions per minute. The results of trials of the *Neptune* cannot be given here, but the fact has been published that her performance was not as good as that of the *Cyclops,* the difference being attributed to less efficient propellers and to inefficiency in the turbine. It is reported that the gearing works in an entirely satisfactory manner.

The following table shows comparisons of the known data concerning the equipments of these three vessels:

	Cyclops.	Jupiter.	Neptune.
Displacement, tons	20,000	20,000	20,000
Indicated horsepower at 14 knots	5,600	....	....
Engine or turbine speed at 14 knots, revolutions per minute	88	2,000	1,250
Propeller revolutions per minute at 14 knots	88	110	135
Weight driving machinery, tons	280	156	....
Character, driving machinery	2 triple expansion engines.	1 turbo-generator and 2 motors.	2 turbines each with gearing.
Steam consumption in pounds per shaft horsepower per hour,	14 (estimated)	12 (tested)	......
Speed maintained on 48 hours' trial, knots	14.6		13.9

While it is believed that the equipment of the collier *Jupiter* is very far superior in efficiency, lightness, and simplicity to anything which has previously been used in such a ship, it should be borne in mind that the vessel is not of a class in which electric propulsion affords its greatest measure of advantage, and its adoption by the government in the case of this ship was in the nature of an experiment to compare this method with other methods available.

Since this method was first proposed in connection with one of these government colliers, the rapid development of designs of high-speed turbines and of electrical apparatus has continued, and the engineering reasons for the use of electric propulsion have been materially strengthened. While the original turbine for the *Jupiter* was being built, a better and simpler method of design was developed, and this was subsequently applied in changing the design of the machine, which through this change was improved in efficiency nearly 10 percent. The desired improvements, however, could only be partially applied within the limitations of time and space, and the machine as it stands is not up to the highest existing standards.

Within this time also, the needs of reversal in ships have been very carefully studied and certain developments in induction motor design have made possible the adoption for such purposes of motors of a simpler type than those used in the *Jupiter.* The equipment of this ship, therefore, although simple, practical, and efficient, is not up to the highest standard now attainable.

The *Jupiter* is propelled by one turbine generating unit with an induction motor coupled to each of the propeller shafts. The generator is of the three-phase type, designed for about

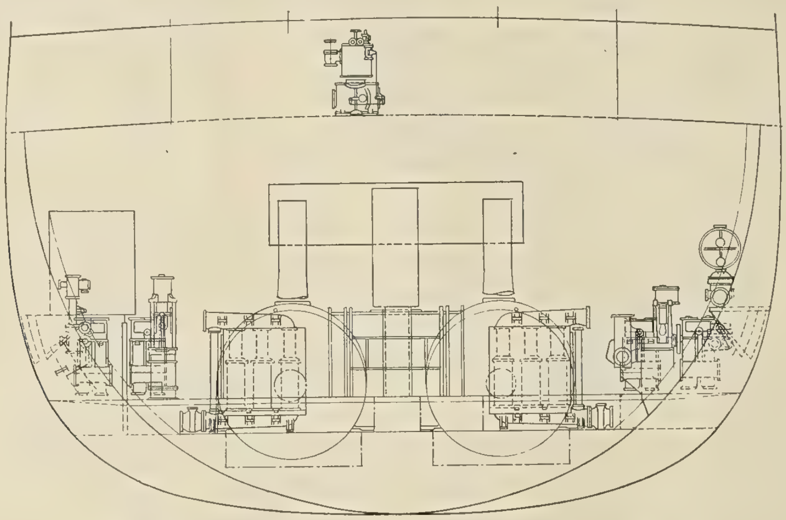

FIG. 3.—ELEVATION LOOKING FORWARD FROM FRAME 173 TO FRAME 163

Fig. 4.—Rotor for Motor

Fig. 6.—Stator for Motor

5,000 kilowatts at about 2,300 volts. At 14 knots, which is the normal speed of the ship, it will run at about 2,000 revolutions per minute, and at this speed the motors will run at about 110 revolutions per minute, there being two poles in the generator and 36 poles in each of the motors. The ratio of speed reduction, disregarding slip of the motors, is 18 to 1.

The generating unit is quite similar in design and construction to such machines as are generally used on shore for electric lighting and power purposes. Its speed is controlled by a governor similar in construction to that used in turbo-generator units. This governor is different, however, in the respect that it is specially designed for adjustment through a wide range of speeds, so that by displacement of a fulcrum in the system of levers operated by the governor the turbine can be held at any speed from that corresponding to the highest

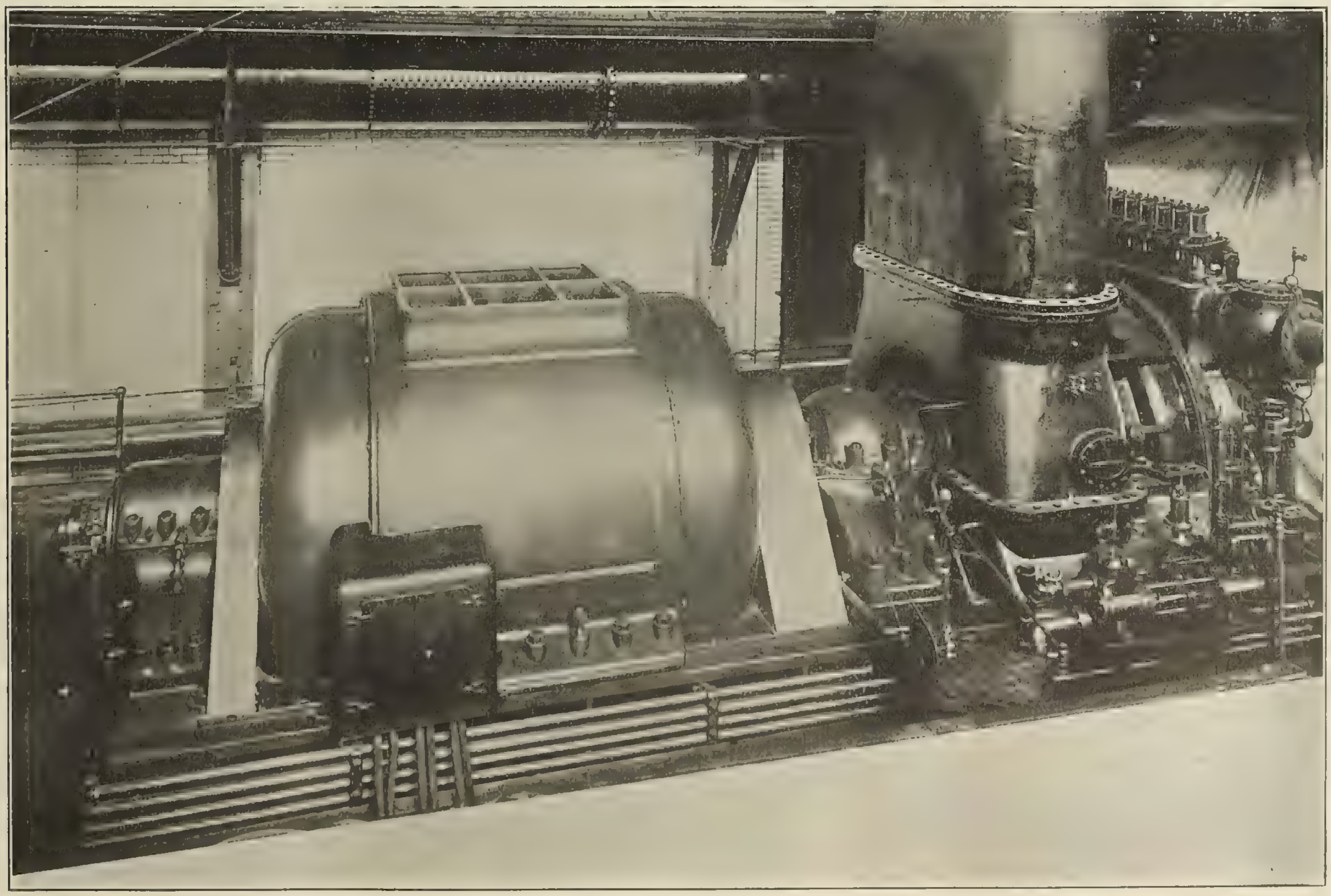

Fig. 5. Turbo-Generating Unit, Assembled at Works of General Electric Company for Test

speed of the ship down to a speed corresponding to only 4 or 5 knots. The action of this governor opens and closes multiple admission valves on the turbine, and this means will ordinarily be used in controlling the speed of the ship. The speed is, however, independently controlled by a throttle valve in the main steam admission, and this throttle valve is designed to be tripped automatically at a speed slightly in excess of the maximum used, by a centrifugal device which is entirely independent of the governor mechanism. Thus while the governor affords a convenient and highly efficient method of control and speed variation, its presence in no way interferes with the operation of the turbine by throttle in the manner usually employed in the control of marine steam turbines. The speed of the governor is set from a dial controlling stand near the switchboard, which operates the mechanism through a simple system of bell cranks and rods below the floor. When the hand of this controlling dial is moved to a speed below that for which the governor is adjustable, such movement causes a complete closing of all the valves, so that this dial affords a means of positively shutting off the steam admission, which is entirely independent of the main throttle.

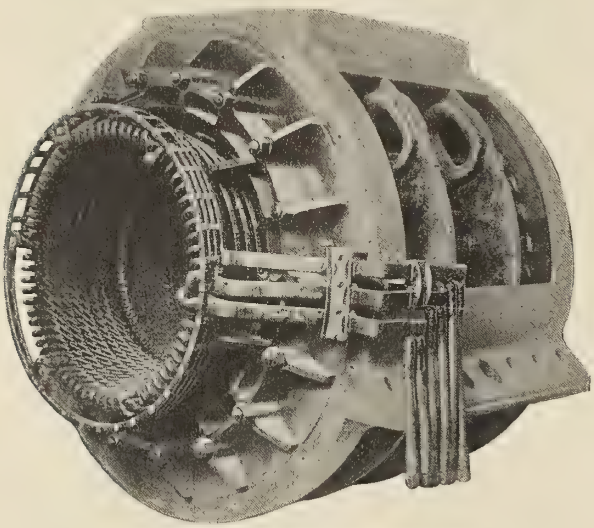

FIG. 7.—ARMATURE FOR GENERATING UNIT

The governor is mounted on a vertical shaft, driven by a gear from the main shaft. On the lower end of this governor shaft a gear pump is mounted, which circulates oil through the bearings, and which also supplies oil to the hydraulic cylinder which governs the admission valves. An auxiliary steam pump is also mounted on the turbine base, which can be used for these purposes. The points where the shaft passes through the turbine shell are fitted with carbon ring packings made in segments and held together by garter springs. These are in separate compartments with chambers between them, and these chambers are either supplied with sealing steam or are connected to drains which extend to the low-pressure parts of the machine. The heat generated in the bearings is carried away by water, circulated in ducts provided for the purpose.

The turbine delivers steam to the condenser through an opening at the top and is fitted with drains by which water which condenses in its shells will pass by gravity to the hot well pump. The heat generated by losses in the iron and copper of the generator is carried away by currents of air induced by impellers attached to the ends of the rotor. The supply of air for this purpose is drawn from the space below the engine room floor and the heated air is discharged at the top of the generator. From this point it is conveyed by a sheet metal duct to a space forward of the engine room bulkhead, in which the Howden draft blowers are installed. The heated air from the motors is similarly conveyed, so that the heat lost from the electrical apparatus is returned to the furnaces.

The motors are of the three-phase induction type and have 36 poles. Their frames are of cast steel and are covered by sheet metal housings, which confine and carry away the heated air. Each motor is installed in a well surrounded by a combing, so that it cannot easily be filled by sea water. The windings are waterproof and not at all sensitive to wet. The motors would probably run successfully when partially submerged, but it would, of course, be better not to operate in this way. The pits afford a large amount of space below the level of the windings.

The rotor windings of motors are connected to collector rings which under nomal conditions of operation are short circuited by a slider on the shaft. These collector rings are connected through brushes to a water-cooled resistance through which a small amount of water is carried from the circulating pump. This resistance is provided for the purpose of affording a large torque in the operation of reversing. While this resistance is in circuit, the motor exerts a powerful torque, even when it is moving in a direction opposite to that of the generator, while without the resistance the motor torque only becomes high as it approaches a speed synchronous with that of the generator. When this resistance is in circuit, the current which flows through the motor is always limited and the motor can be switched on and off, stopped, started, and reversed with full voltage on the generator by simply pushing the switch handles in and out. When the vessel is being maneuvered in narrow waters where frequent reversals may be required, the resistance can be kept permanently in circuit as a matter of convenience in handling. Under this condition the vessel would be limited to about three-fourths speed and the operation would be less efficient than when running without resistance.

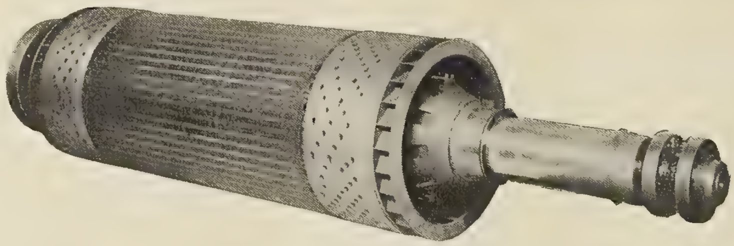

FIG. 8.—REVOLVING FIELD FOR GENERATING UNIT

When the motors are operated without resistance, their speed is normally very nearly synchronous with that of the generator and their operation is highly efficient. If they were reversed in this condition they would draw a large current from the generator, but would produce a comparatively small torque on the propellers. It is therefore desirable, where prompt reversal is required, to cut the resistance in the motor circuit. This is done by levers attached to the motor frames, but it cannot be done while the circuit is alive. Reversal under such conditions is accomplished by first opening the field switch which de-energizes the circuit, then moving the levers which cut in the resistances, then throwing the reversing switches, and lastly re-establishing the field circuit. These operations are quite simple and can be accomplished in a very few seconds, and locking devices are provided by which they cannot be accomplished in the wrong order. The resistance levers are secured by electric locks which do not admit their movement until after the field circuit has been de-energized. The reversing switches are interlocked with the ahead switches, so that both cannot be closed at the same time. Both the go-ahead and reversing switches are mechanically interlocked with the resistance levers, so that they cannot be closed while the motor resistance is cut out.

While the resistance with its accompanying mechanisms affords means of quick and very powerful reversal, it is not essential to the reversal of the ship. The ship can be backed with a good power without the resistance by lowering the speed of the generator. Under such conditions the motors will bring the propellers to rest and start them in a reverse direction. Their speed will then increase until it is nearly synchronous with the reduced speed of the generator, after which the generator and motors can be brought up together with the full power available in the turbine.

FIG. 9.—WATER-COOLED RHEOSTAT

The switchboard is fitted with four oil switches, one for going ahead and one for reversing on each motor. It is also provided with switches which open the field circuit of the generator and the field circuit of the exciter. It is also provided with instruments which show the current in the circuit of each motor, the voltage at the generator terminals, the power delivered to each motor in watts, and the speed of the generator as indicated by the electrical frequency. The switchboard is also fitted on its base with integrating watt hour meters which record on dials the total power which the motors consume.

The excitation of the turbine driven alternator is provided by any one of three turbine-driven direct current generating units which can be used either for this purpose or for delivering lighting and power for the ship. This group of units is provided with a switchboard with arrangements by which any one of them can be set apart as an exciter for the propelling machinery. When connected for this purpose, its voltage is controllable by a rheostat on the propelling switchboard and its circuit can be opened by a suitable switch provided on that board. The degree of excitation required on the main generator depends upon the amount of power required, and the most economical condition of operation will generally correspond to the lowest exciting voltage which can be used at such speed. The exciting voltage required under each condition of speed will be shown by experience. If this voltage is reduced too low, the motor will fall away from synchronism, which will be shown by a sudden rise in its current. Under such conditions it can be restored to synchronism by simply lowering the generator speed and slightly increasing the exciting voltage so that it will hold at the speed desired.

Launch from the Harbor Dockyard

On Monday, July 7, Messrs. Irvines' Shipbuilding & Dry Docks Company, Ltd., launched from the Harbor Dockyard, West Hartlepool, the steel screw steamer *Eustace,* built for Messrs. The Pyman Steamship Company, Ltd., West Hartlepool (Messrs. George Pyman & Company, managers). The dimensions of the vessel are 387 feet by 51 feet 3 inches by 26 feet 10 inches depth, molded, carrying over 7,400 tons on a moderate draft. She is built to Lloyd's highest class on the shelter deck principle, having two complete steel decks, and water ballast is carried in the cellular double bottom and fore and after peaks. The vessel is constructed with deep frames without side stringers, giving exceptionally clear holds for the stowage of bulky cargoes. Wood grain divisions are fitted throughout the holds to Board of Trade requirements, and the steamer is divided into seven watertight compartments by six transverse bulkheads. Large hatches are provided, together with the latest facilities for the rapid loading and discharging of cargo, including ten powerful steam winches exhausting into a winch condenser, and ten derricks. A powerful quick-warping steam windlass is fitted forward, with steam steering gear amidships and hand gear aft. Triple expansion engines will be supplied and fitted by Messrs. Blair & Company, Ltd., Stockton-on-Tees, having cylinders 25 inches, 42 inches and 68 inches by 48 inches, with two large single-ended boilers and one auxiliary boiler, all connected up to the main engines, and furnishing steam at 180 pounds pressure.

The Year's Shipbuilding in the United States

During the year ended June 30, 1913, there were built in the United States 1,648 vessels, of 382,304 gross tons, officially numbered by the Bureau of Navigation, which, compared with 1,720 vessels of 243,792 gross tons for the same period of 1911-1912, shows a gain of 138,512 gross tons, or 57 percent. This is the largest construction in the United States since 1908. Of the total tonnage constructed, 225,467 gross tons, or 59 percent, were steel steamships, of which 62 percent was built on the Atlantic and Gulf coasts, 30 percent on the Great Lakes, and 8 percent on the Pacific coast. The most important part of the shipbuilding industry is the construction of steel steamships, and in this respect the shipyards on the Atlantic coast showed the greatest activity. Here 58 steel steamships, aggregating 138,617 gross tons, were built, as compared with 33, aggregating 39,682 tons a year ago, or an increase of 250 percent. On the Pacific coast there was an increase of 380 percent in the construction of steel steamships, 16, aggregating 17,533 gross tons, being built last year, as compared with 10, aggregating 3,658 gross tons, for the year before. On the Great Lakes, however, there was a decrease of 14 percent in the construction of steel steamships.

French Battleships Provence and Bretagne

The French battleships *Provence* and *Bretagne* were launched by the Lorient and Brest Dockyards on April 20 and 21, respectively. The keel of the *Provence* was laid May 1, 1912, and that of the *Bretagne* July 22, 1912. Both battleships were launched according to the French dockyard practice; that is, with only a single sliding way directly under the keel. The launching weight of the *Provence* amounted to 8,400 tons, including the cradle. The sliding way was 498 feet long, 48 inches wide and 16 inches thick, the declivity of the ways being 8.06 percent. The launching weight of the *Bretagne* was 8,300 tons, the sliding way in this case being only 443 feet long, 48 inches wide and 22 inches thick, with a declivity of only 6 percent. Both launches were successfully carried out.

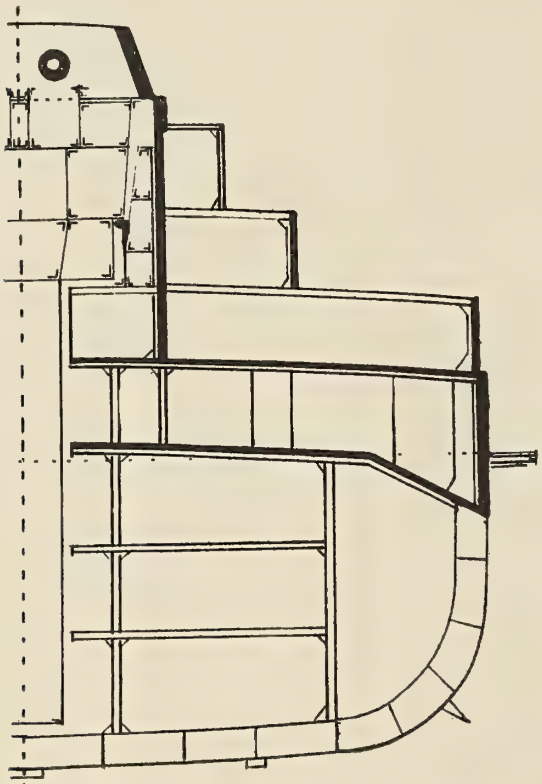

FIG. 1.—SECTION OF BATTLESHIP BRETAGNE AT FORWARD TURRET

The main particulars of these vessels are: Length over all, 545 feet; beam, extreme, 88 feet; draft, forward, 27 feet 11 inches; aft, 29 feet 3 inches; area of 'midship section below load-waterline, 2,752 square feet; displacement at normal draft, 23,546 tons; brake horsepower, estimated, 28,000; speed, estimated, 20 knots.

From the double bottom (which extends up the sides to the lower protective deck) to the spar deck there are two twin decks—the lower protective deck, the upper protective deck, the gun deck and the spar deck.

Armor

The ship is protected by a belt of armor extending from stem to stern and from a distance 5 feet 7 inches below the load-waterline to a height of 7 feet 9 inches above the load-waterline. The main belt of armor is 11 inches thick between the forward and after turrets and 7 inches thick to the stem and stern. Behind all the armor there is a backing of 3-inch teak.

For a length of about 197 feet from turret No. 1 to the after funnel, extending from the upper edge of the main armor below to the spar deck, there is an armored citadel protected by 7-inch armor. At both the forward and after ends of the citadel there are 'thwartship armored bulkheads of the same thickness. The secondary armament, the base of the funnels, the conning tower and turret No. 5 are, therefore, well protected. On both sides of turrets Nos. 4 and 5 are casemates for the secondary armament, similarly protected. At a point aft, not far from the stern, there is a cross-bulkhead of 7-inch armor connecting the two sides of the armor belt.

There are two protective decks; the lower one of 1⅝-inch plates on the flat and 2¾-inch plates on the slopes, the upper one of 1¾-inch plating throughout. The lower protective deck extends from the lower edge of the main armor belt; that is, 5 feet 7 inches below the load-waterline at the wings, and is at about the level of the load-waterline at the center line. The upper protective deck extends from end to end of the ship at the level of the upper edge of the main armor belt. The central part of the ship—that is, the space between the two protective decks— is encased by armor, and is divided as follows: From the outside, armor plate, a cofferdam, a passage, two store or bunker rooms, another passage, a storeroom and the central passage.

Below the lower protective deck the hull is divided into a number of main watertight compartments by transverse bulkheads connected with at least one or two longitudinal bulkheads. Each of these main compartments is again subdivided into several smaller ones. The thickness of the bulkhead plating is graduated in order to provide sufficient strength in case one compartment is flooded up to the level of the lower protective deck.

In order to insure greater safety, each of the main engine and auxiliary compartments is formed by solid bulkheads without watertight doors, access to these compartments being obtained by special entrances from the deck above.

According to the practice of the French navy the ship is equipped with only a single rudder, and that of the balanced type, the framing being of cast steel.

Machinery

Steam is supplied by two groups of boilers, each group having a single funnel. The first group is divided into three boiler rooms, while the second group is all contained in a single boiler room. The boilers are designed so that they can be fired with either coal or liquid fuel. The boilers of the *Bretagne* were supplied by Messrs. Niclausse, while the boilers for the *Provence* were built by the Navy Works, Indret. The main features of these boilers are:

Bretagne

Number of boilers	24
Total grate surface	2,090 square feet
Total heating surface	64,660 square feet
Steam pressure	256 pounds
Tubes:	
Number of elements	380
Number of tubes	9,784
Length	7 feet 10 inches
Outside diameter	3 5/16 inches
Inside diameter	3 inches
Area of section of forward funnel	148 square feet
Area of section of after funnel	76 square feet
Height of funnels above the load-waterline	66 feet

Provence

Type of boilers	Guyot du Temple
Number of boilers	18
Total grate surface	1,492 square feet
Total heating surface	62,585 square feet
Steam pressure	256 pounds
Tubes:	
Inside diameter	1 3/16 inches
Outside diameter	1 7/16 inches
Height of funnels above grate bars	96 feet 5 inches

Coal consumption allowed per contract, 10-hour full power trial, 2,700 pounds per mile. Three-hour full power trial, forced draft, 321 pounds per square foot of grate area, pressure in boiler rooms 1 inch of water. Twenty-four hour trial under normal draft, 1,853 pounds per mile. Consumption trial, with one-half boilers at work, 1,168 pounds per mile.

Under ordinary circumstances 900 tons of coal are to be carried, but there is ample room for carrying 2,700 tons, and with this amount of fuel the ships will have a theoretical cruising radius of 8,500 miles at a speed of 10 knots, and a range of 2,500 miles under full speed (20 knots).

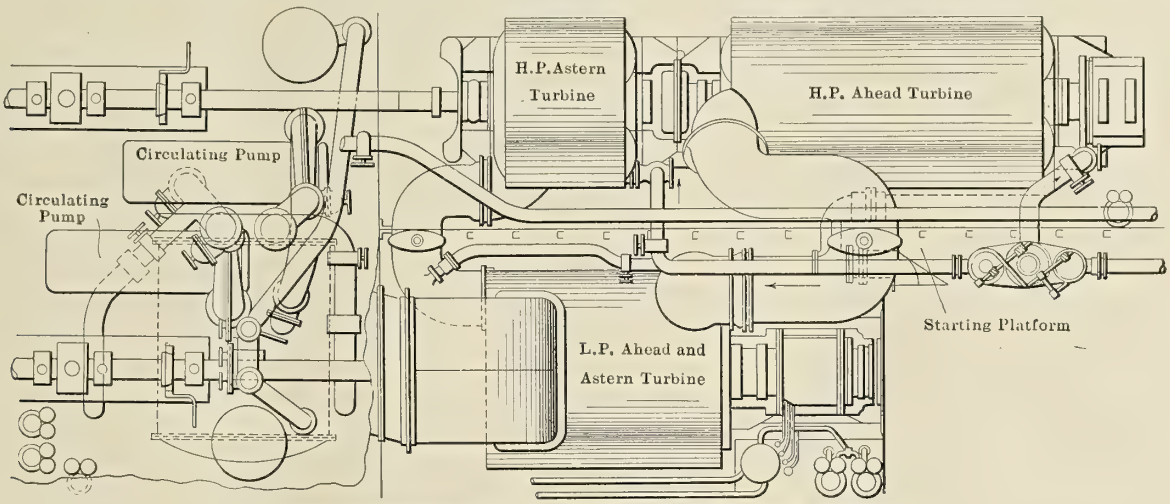

FIG. 2.—ARRANGEMENT OF PORT TURBINES ON BATTLESHIP PROVENCE

Both battleships are engined with Parsons turbines, those for the *Bretagne* being supplied by the Forges & Chantiers de la Mediterranée, and those for the *Provence* by the Ateliers & Chantiers de la Loire. In each case the turbines drive four shafts, although the arrangement is different from that in the *Voltaire* class. In these ships there are no cruising turbines, and this enables the designers to divide the turbines into two separate and independent sets—the starboard and the port sets. The high-pressure turbines are mounted on the wing shafts and the low-pressure turbines on the inner shafts. The impulse sections of the high-pressure turbines consist of four wheels for ahead working and two wheels for the astern turbines. The wheels have a mean diameter of 11 feet 2 inches, each being divided into four stages. Admission of steam is regulated by a number of nozzles at the impulse end, and the number of nozzles set at work regulates the speed of the turbines and gives good economy at low speeds, without the necessity of installing cruising turbines. These turbine installations are designed to develop 28,000 brake horsepower when running at 300 revolutions per minute to give the ships a speed of 20 knots.

The main condensers are located aft of the low pressure turbines in two watertight compartments, the cooling surface is 32,000 square feet, and they have been designed for condensing the full quantity of exhaust steam when the engines are running at full speed and maintaining a vacuum of 27.6 inches with cooling water at 15 degrees C.

The auxiliaries, such as capstans, windlasses, etc., which require large power, are actuated by steam, while all others are driven by electric motors. The electric plant consists of four dynamos, each of 200 kilowatts capacity. Fore-and-aft near the turrets are two other similar generating sets for supplying electricity for operating the turrets. The total electric power on board the vessels amounts to 1,650 horsepower.

The ammunition rooms are ventilated by electrically-driven fans, which are so designed that by the use of the fans alone the maximum temperature of 25 degrees C. will not be exceeded. In order to obtain a lower temperature a special refrigerating plant has been provided, consisting of three sets of Westinghouse-Leblanc apparatus.

ARMAMENT

The *Provence* and *Bretagne* are the first French battleships to be equipped with armament heavier than the usual 12-inch guns. The main battery consists of ten 13.5-inch guns, located in five turrets, all on the centerline of the vessel—two forward, two aft and one about 'midships. The turrets are protected by 13.5-inch plates on the front, 10-inch plates on the sides and 11-inch plates at the base. The respective heights of the turrets above the load-waterline are: Turret No. 1, 30 feet 6 inches; No. 2, 37 feet 9 inches; No. 3, 33 feet 6 inches; No. 4, 28 feet 7 inches, and No. 5, 21 feet 4 inches. Turrets Nos. 1 and 5 have an arc of fire of 135 degrees; Nos. 2 and 4, 140 degrees, and No. 3, 120 degrees on each side. The fore-and-aft fire consists of four 13.5-inch guns, while all the guns can be used on either broadside. It is reported that the 13.5-inch guns are about 67 feet in length; weigh 66 tons each, and throw a shell weighing 1,190 pounds.

The secondary armament consists of twenty-two 5.5-inch guns, placed in five groups on each side of the ship. These guns have an arc of fire of 120 degrees, and throw a shell weighing 80 pounds. The guns located in the main citadel are 19 feet above the load-waterline and, in the after casemates, 12 feet above the load-waterline.

The armament also includes four 18-inch torpedo tubes, located two forward and two aft.

Lloyd's Register Shipbuilding Returns.—The returns compiled by Lloyd's Register of Shipping, which only take into account vessels the construction of which has actually begun, show that, excluding warships, there were 543 vessels of 2,003,241 tons gross under construction in the United Kingdom at the close of the quarter ended June 30. The tonnage now under construction is 60,000 tons less than that which was in hand at the end of the last quarter, but exceeds by about 229,000 tons the tonnage building in June, 1912.

Rebuilding a Double Bottom Under Engines

BY ENRICO BENVENUTI

A very important piece of repair work, which is rarely undertaken in marine engineering, was carried out recently in a special manner in Genoa harbor. One of the larger Italian mail steamers, built in 1908, and owned by one of the most important Italian steamship companies, for some time gave trouble on account of imperfect workmanship on the double-bottom plating under the main engines.

The trouble first began by frequent breaking of the holding-down bolts of the engines; but as no further danger was evident, and as the bolts which gave trouble were not fitted in the bedplate holes, it was believed to be a question of unequal bolt strains, consequently the bolts were replaced by other bolts of greater diameter which fitted well in the bolt holes.

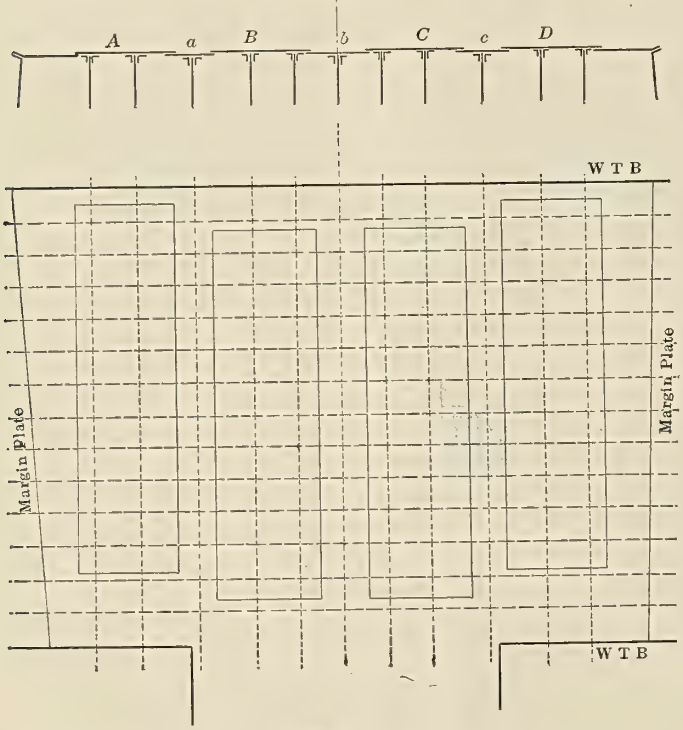

FIG. 1

This repair proved satisfactory during one or two transatlantic voyages, but after that a much more serious trouble became evident. The riveting of the double bottom plating began to loosen and the double bottom began to leak. Owing to the unsteadiness of the plating the engines themselves became unsteady, with the serious possibility of breaking the main steam pipes between the after bulkhead and the high-pressure valve chests. The necessity of undertaking the general reconstruction of the double bottom plating under the main engines was therefore decided upon.

The original construction of the double bottom of the ship in the engine room was as shown in Fig. 1. There was a center keelson and five side keelsons on each side, and two margin plates with double angles securing all these members to the plating. The plates and angles of the keelsons, etc., were all of more than sufficient scantlings for the design. The double bottom plating, however, was as shown in Fig. 1. There were four main plates, *A, B, C* and *D,* 30 feet by 7 feet by 1 inch thick under the engine bedplates, while the remaining plates in the double bottom, *a, b* and *c,* were only ½ inch thick.

After a complete examination of the structure the technical staff of the steamship company and the surveyors of the Italian Register agreed upon the necessity of carrying out the following work:

Complete disconnection of the double bottom plating, the substitution of 1-inch plates for the ½-inch plates in the double bottom, the new plates to be joggled riveted upon the four main 1-inch plates already in the double bottom, as shown in Fig. 2, the drilling of all the rivet holes, and re-riveting the double bottom with 1⅛-inch rivets. The new plates to be put in were 27 feet long by 3 feet 7 inches wide.

The two triple-expansion engines, each of 3,800 indicated horsepower at 83 revolutions per minute, had bedplates 24 feet by 14 feet 6 inches, and were 26 feet high to the cylinder covers. Owing to the short time available the technical staff of the company resolved not to unship the engines, or to dismantle any part of them. The repairs were carried out as follows:

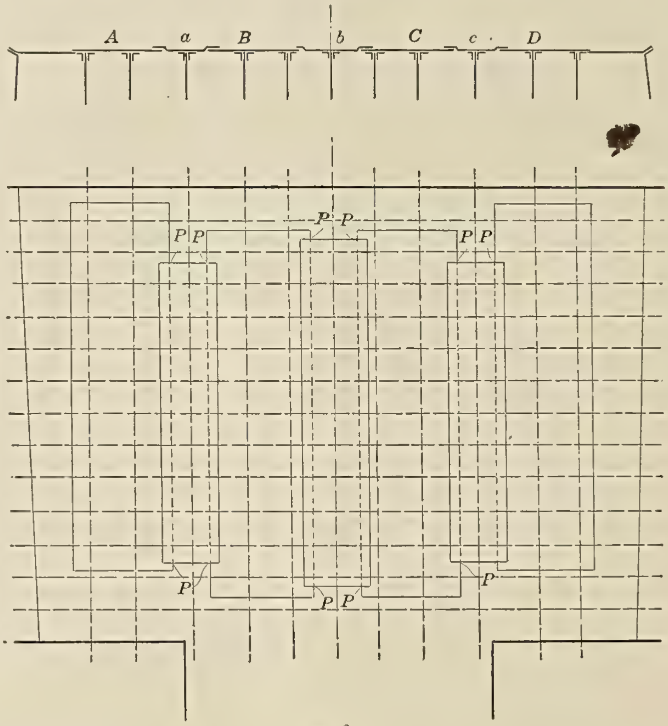

FIG. 2

First the starting platform and some of the lower gratings were removed, the engines were detached from the water and steam piping, and all the holding-down bolts were removed, and the high-pressure crankshafts were turned over 180 degrees, so as to have the three crankshafts of each engine placed as in Fig. 4. Two wooden guides were then placed between the cylinders of each engine, and the side wall of the engine room casing and wooden slippers were fixed to the cylinders, as indicated in Fig. 3. Also two differential blocks were attached to the top of each engine.

Below each crankshaft a hydraulic jack of 150 tons' capacity was placed, as shown in Fig. 4. The hydraulic pumps were located between the engine, and their manometers were placed in a conspicuous place near the pumps. One engine at a time was then raised.

During the raising the hydraulic rams were worked with gradually-increasing strains from the high-pressure to the low-pressure end of the engines, and the whole weight of each engine was found to be about 200 tons. As the engine was jacked up double wooden blocks were placed below each column, and the differential blocks fastened to the top of the engine were kept under tension.

After each lift of 8 inches the hydraulic rams were replaced at the starting point of their stroke, and in this manner the two engines were lifted 3 feet above the double bottom plating.

The disconnection of the plating was then undertaken by means of oxy-acetylene apparatus, and the three plates, *a*, *b*, *c*, Figs. 1 and 2, which were to be changed, were cut into several pieces by the oxy-acetylene apparatus and then taken out.

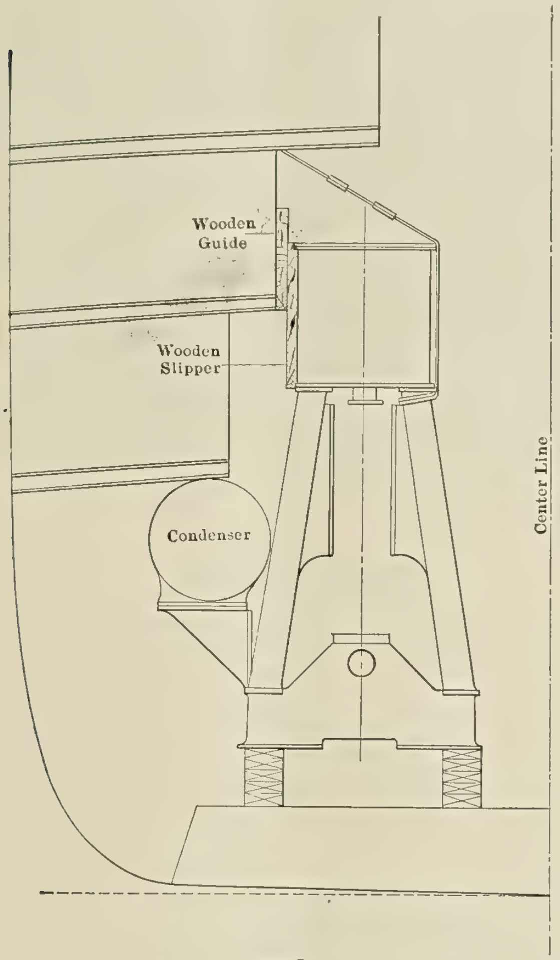

FIG. 3

A disagreeable surprise was experienced at this time, as the countersinking of the double rows of rivets on the edges of the main plates, upon which the engines were seated, had been so badly done by the builders of the ship that it was impossible to drill them for riveting to the new joggled 1-inch plates.

This difficulty was overcome by brazing some iron inside each hole with the oxy-acetylene apparatus and reducing its diameter to about 5/8 inch. This method succeeded very well and required only about four days' time for completing 1,000 holes. After this was accomplished the holes were enlarged to 1 inch diameter by means of pneumatic drills, and three wooden templates, carefully worked, were built in place for the new joggled plates. During the time these plates were being finished at the shop, the pneumatic drilling and hand-riveting of the plates which were not to be renewed was accomplished on board the ship.

Taking away in turn one or the other of the two blocks placed below each cylinder column, it was possible to carry out all the riveting of the double bottom just as if the blocks were not there. Each block remained disengaged by forcing in the two tapered wooden pieces of its sister block.

The work of putting in place under each engine one of the 27-foot by 3-foot 7-inch by 1-inch plates was carried out as follows:

The plate was laid on the double bottom plating between the two engines, the three hydraulic jacks were again put in place under the crankshafts, and the six front blocks on which the engine was supported were temporarily removed. Having taken care to reduce to a minimum the transverse breadth of the base of each hydraulic jack, it was possible after the new plate was rolled under the engine to put the front blocks in place again, as shown in Fig. 5, and then by removing the jacks the plate could be put in its proper location.

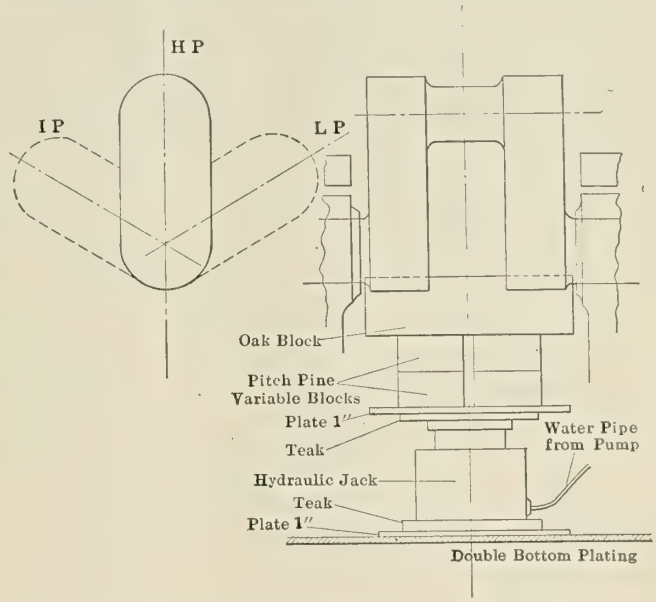

FIG. 4

After repeating this work for the two engines the new center plate was put in place, for which no special work was required. The holes in the plates, which had been punched in the shop 7/8 inch diameter, were enlarged to 1 1/8 inches diameter by pneumatic tools, as all the riveting was to be done by hand with 1 1/8-inch rivets. After the riveting was accomplished the calking was done by pneumatic tools.

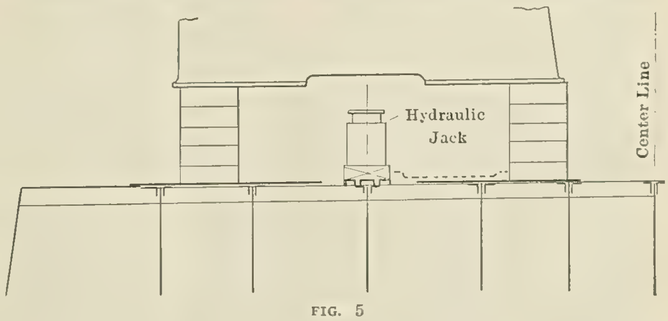

FIG. 5

Another part of the job which presented some difficulty was the fact that the new plates and seams needed to be made watertight at points marked *"P"* in Fig. 2. For doing this a system of electric brazing was used in the following manner: At each point which was to be made watertight a piece of iron 1 foot long, properly shaped, was forced into the space between the plates. This liner was forced in until the end of the piece was flush with the butt of the plating. The current for the electric brazing was furnished by the ship's dynamo, working at 60 volts. A small block of melted iron was attached on the sunken plate in front of the point which was to be made watertight, in such a manner as to wholly cover the opening into which the liner had been forced. Twelve points required electric brazing, and the whole work was accomplished in 30 hours.

After the above work was accomplished the entire double bottom plating under the main engines had been rebuilt, all the plating being now 1 inch thick. The three hydraulic jacks were again put in place under each engine with their rams at the highest point of the stroke, and by lowering all the wooden blocks a distance of 2 inches each time, and allowing the water to discharge slowly through the pump cocks inserted between the pumps and the jacks, both engines were replaced on the new double bottom in less than two hours. After that all that remained to be done was to fit up the piping. The whole repair job was carried out almost entirely by the ship's crew, except for the blacksmith's work and the operation of the oxy-acetylene and the electric brazing apparatus. For the whole job the ship was detained in the harbor only forty-five days.

Motor Vessels for the German Navy

BY J. RENDELL WILSON

Apart from several large combined motor and steam warships projected for the Imperial German navy, in which the Kaiser is taking great interest, there are quite a number of small Diesel driven vessels attached to the fleet and dockyards. Of the latter the latest is a boat that has just been built at the Royal Dockyard at Kiel-Gaarden for the use of the commander of the North Sea Station at Helgoland. The engines, however, were constructed by Messrs. Benz & Co., of Mannheim. *Kommandantur Helgoland*, as she is named, is practically a raised deck type motor yacht, rather than a war vessel, and is 64 feet long by 13 feet beam and 4½ feet draft. Over the raised deck just forward of midships there is a fully closed-in pilot house, aft of which are the funnel and the

KOMMANDANTUR HELGOLAND

engine room skylights, and abaft again is a pole mast. The funnel is for carrying away the exhausts and for ventilation. Then comes another cabin and a cock pit.

The propelling engine has considerable interest, as it is a Diesel of the Benz-Hesselman two stroke type—that is to say, there are four working and two maneuvering cylinders, operated off the same crank shaft. The two forward cylinders contain double acting air pumps, which when the engine is running are used to supply air for scavenging the working cylinders. Control of this air is through ports in the walls of the working cylinders. For starting and reversing these two pumps become compressed air engines, control being by piston valves. By adopting this system it is only necessary to have one valve in the head of each working cylinder, namely, the fuel valve. Not only does this render the construction of the cylinder head much stronger, but the strains and stresses due to cold compressed air suddenly entering the hot working cylinders when maneuvering is thus almost entirely eliminated, as the only compressed air entering the main cylinders is the fuel injection blast. The importance of strong cylinder head construction with Diesel engines cannot be overrated, and some of the slight troubles experienced with motor

VEDETTE BOAT KAISER

ships in service have been due to cracked cylinder heads. One large marine Diesel engine completed about a year ago has no fewer than six valves, including two for scavenging, consequently the head can be little more than a valve cage. As yet this engine has not been installed. Indications tend to show that if the two stroke engine becomes generally adopted, it will be of the port scavenging class.

On trials the engine of *Kommandantur Helgoland* developed 175 indicated horsepower at 300 revolutions per minute, giving the vessel a speed of 10½ knots. Supposing a mechanical efficiency of 62 percent, the shaft power would be 109 brake horsepower, but probably the actual brake horsepower was nearer 120. The fuel consumption was 0.232 kilogrammes of gas oil of 39,600 B. t. u. per brake horsepower. Maneuvering trials were also carried out and the engine was started ten times in five minutes without emptying the air storage bottle. For reversing from full speed ahead to full astern the average time was seven seconds, the quickest being five seconds, which is quicker than most steam engines. The lowest engine revolutions were 160 per minute. At the trials the German Admiralty expressed their satisfaction regarding the running and maneuvering of the machinery.

Another Benz Diesel-engined boat just built for the German navy is the *Kaiser*, a vedette cruiser 49 feet long by 6 feet 6 inches beam by 3 feet 3 inches draft. She is entirely decked in except for a cock pit aft. Her engine develops 100 horsepower, and instead of being of similar construction to the one just described, they are of the four-stroke type. Messrs. Benz have engines for two sister craft under construction, also two 120 horsepower motors for two boats for the Friedrichsort torpedo range. Altogether they have built, or are building, 27 marine Diesel engines for commercial and naval craft, including three 530 horsepower tug boats.

Illuminating Engineering Society.—The annual convention of the Illuminating Engineering Society will be held at the Hotel Schenley, Pittsburg, Sept. 22 to 26.

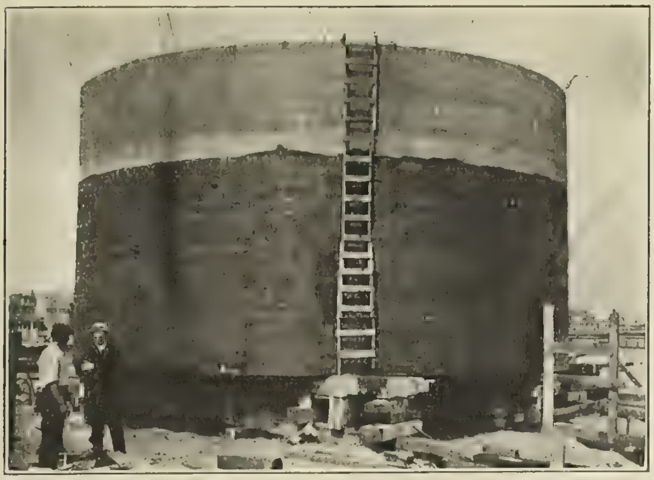

FIG. 1.—CONCRETE CAISSON TO FORM LIGHTHOUSE BASE

FIG. 2.—PREPARATIONS FOR LAUNCHING CONCRETE CAISSON

A Unique Craft

An interesting launching will soon take place at Lewes. Del. It is the launching of the caisson shown in the accompanying photographs which has been constructed alongside of Queen Anne's Pier, about 100 feet from the shore.

This caisson is to form the base of a new lighthouse that is being erected by the Interstate Construction Company near the present lighthouse in Delaware Bay, about ten miles above Lewes.

The caisson is of concrete and weighs 220 tons. It is 35 feet in diameter and 18 feet 6 inches high and will draw about 8 feet of water when afloat. It has outer and inner walls of concrete 6 inches thick and several feet apart with radial webs connecting the two walls. The bottom is also strengthened by deep radial webs.

Some dredging will have to be done in order to launch this unique craft.

When launched it will be towed to its destination and sunk by the admission of water. It will then be firmly secured in place and filled with rock.

FIG. 1.—OCEAN-GOING TUG GUARANY FOR BRAZIL

Twin-Screw Tug for Brazilian Navy

BY F. C. COLEMAN

Messrs. Vickers, Ltd., of Barrow-in-Furness, have delivered to the Brazilian navy the twin-screw tug *Guarany*, illustrated in the photographs and drawings. The *Guarany* is being used for towing battleships and other large vessels in and around Rio harbor, and she has a length between perpendiculars of 128 feet, a breadth, molded, of 25 feet, and a depth, molded, of 14 feet.

The propelling machinery consists of two sets of triple-expansion engines, each set having three cylinders working on three cranks, the collective independent horsepower being 1,200, with a working pressure of 180 pounds per square inch. A piston valve is fitted to each high-pressure cylinder, a trick valve to each intermediate pressure, and a double-ported slide valve to each low-pressure cylinder, separate loose faces being

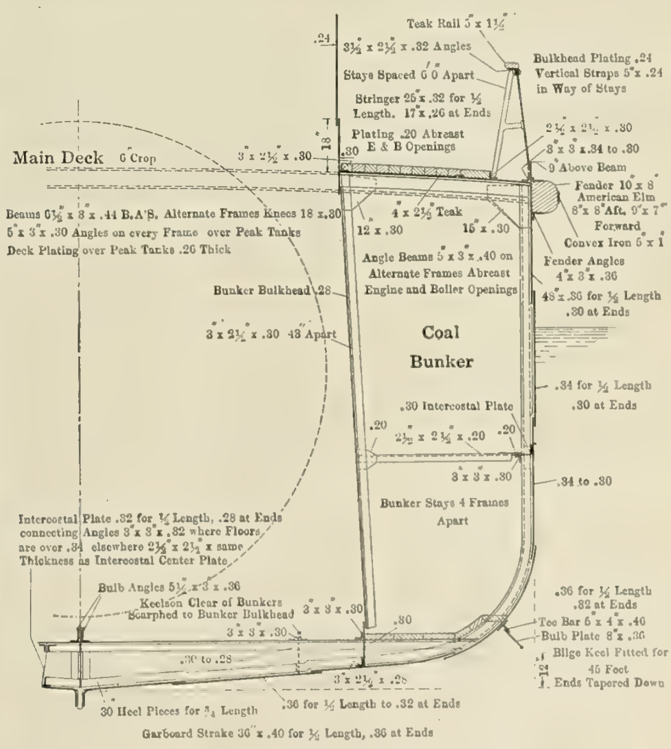

FIG. 2.—MIDSHIP SECTION OF TUG GUARANY

provided in each case. All the valves are actuated by double eccentrics and Stephenson link motion with large bearing surfaces. The bedplate is of cast iron and carries six bearings, the bushes of which are lined with white metal. The shafting is of mild steel in excess of Lloyd's requirements, the crankshaft being built in one length. Steam all-round reversing engines are fitted, the reversing shafts being of wrought steel with cast steel levers shrunk on.

A complete installation of independent steam-driven auxiliary machinery is fitted, and comprises two vertical air pumps, two centrifugal pumps for supplying circulating water to the condensers, one main and one auxiliary feed pump, one general service pump, one sanitary pump and one steam-driven electrical generating set for lighting the ship. Ballast tanks are fitted at the forward and after ends of the vessel for trimming purposes, and the bunkers are of a capacity to hold about 100 tons of coal.

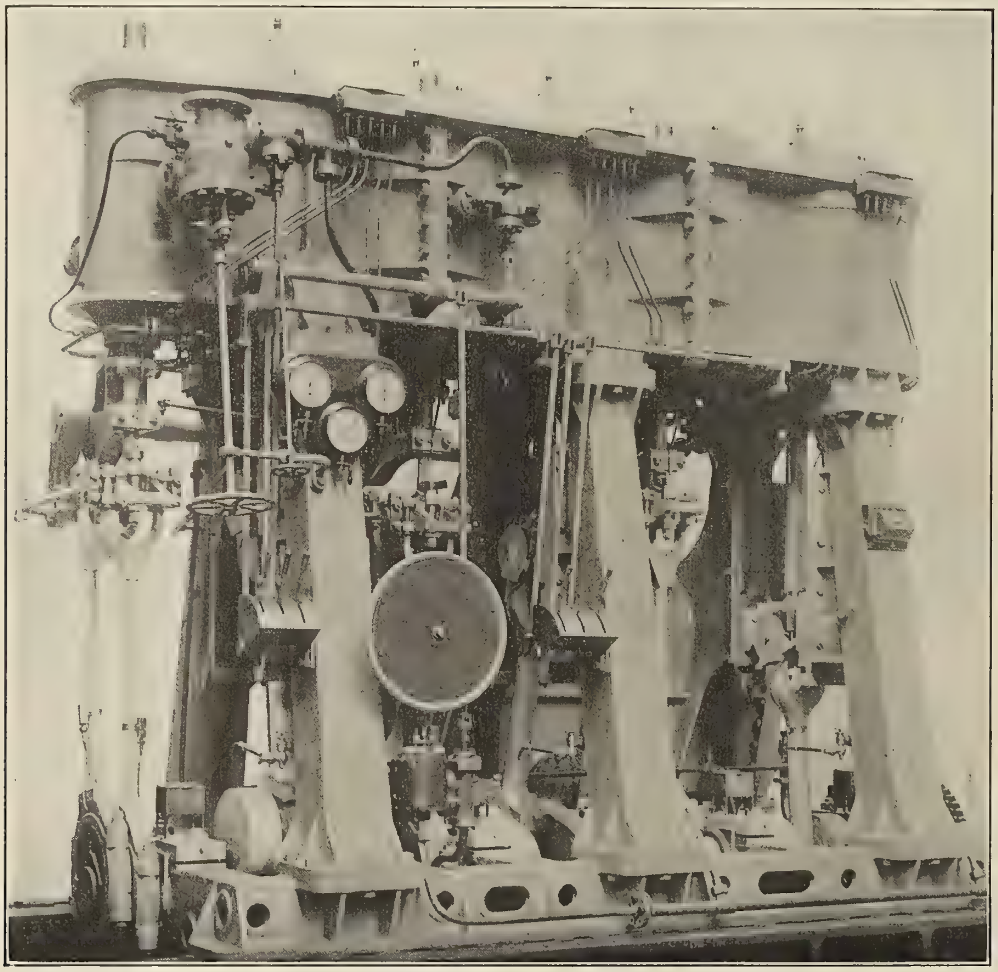

FIG. 3.—ONE OF THE MAIN ENGINES OF BRAZILIAN TUG GUARANY

The officers and crew are berthed on the lower deck forward and aft, with lavatory and bath accommodation on the lower deck.

A powerful salvage pump is fitted on the lower deck forward. A complete set of diving gear has also been provided. Provision has been made aft for lifting heavy anchors by means of a portable steel derrick. A steam steering engine is fitted on the bridge, and the gear is also arranged to work by hand power. A powerful steam windlass and winch are provided on the upper deck forward.

The vessel is lighted throughout with a complete system of electric lights, and is also provided with a powerful searchlight, which is placed on the top of the chart house. Two steel lifeboats are carried on the bridge deck. An installation of wireless telegraphy has also been fitted on the vessel. A very complete system of natural and artificial ventilation has been fitted. Two large towing hooks with springs are fitted, together with the usual towing rails.

The vessel underwent a series of trials off Barrow-in-Furness, and a speed of 11 knots was easily mantained under adverse weather conditions.

Trial Trip of a Steel Screw Steamer

On July 2 the new steel screw steamer *Scythian*, built by Messrs. Ropner & Sons, Ltd., of Stockton-on-Tees, made her official trial trip in the Tees Bay. The steamer has been built to the highest class at Lloyd's, and is of the two-deck type, the second deck being 9 feet below the upper deck. Her dimensions are: Length, 403 feet 6 inches; breadth, 50 feet 6 inches; depth, molded, 30 feet 6 inches, with a deadweight carrying capacity of 7,925 tons on her summer freeboard. She has a full poop, in which are berthed the crew, bridge 115 feet long and top gallant forecastle. Double derricks are fitted to work out each hatchway, and all her appliances for loading and discharging cargoes are very complete, including a special derrick to lift 15-ton weights from either the foremain or after-main holds; she is also fitted with an electric light installation throughout the ship. The engines and boilers have been supplied and fitted by Messrs. Blair & Company, Ltd., of Stockton-on-Tees, and are of the triple expansion type, having cylinders 26 inches by 43 inches by 71 inches by 48 inches stroke, steam being supplied by three single-ended boilers, each 15 feet by 11 feet 3 inches long with a working pressure of 180 pounds. After some very satisfactory trial runs, during which the vessel attained a speed of over 12 knots, she proceeded to the Tyne to load.

How to Increase Marine Terminal Capacity

BY H. McL. HARDING*

As has often been stated, both steamship and railway terminals are not only congested, but this congestion is becoming more and more acute, especially on account of the great increase of miscellaneous or package freight. The composition of many cargoes has radically changed within the past ten years, both in character and in the number of consignees or marks.

On account of the tendency being to convert raw material, at the place of origin, into manufactured products, the bulk shipments do not increase in the same ratio as have those of general merchandise. The tendency is even to change a portion of the grain or corn shipments into packages of breakfast or other foods.

FIG. 1.—MECHANICAL CONVEYOR AT DORTMUND, GERMANY, TRANSFERRING GOODS ELECTRICALLY TO FREIGHT CARS. LOADS ALREADY ASSORTED FOR CONSIGNMENT WILL BE LOWERED UPON A SMALL TRUCK FOR MOVEMENT INSIDE THE CAR

FIG. 2.—MOVABLE TRACKS. ONE ELECTRIC CARRIER AND LOAD IS TRAVERSING THE CROSS TRACK OVER THE YARD AREA, ANOTHER IS UPON THE FIXED SIDE TRACK AND A THIRD UPON A FIXED END TRACK

The importance of the package freight to the transportation companies is considerable, owing to its value permitting freight rates of the higher classifications, and its augmented tonnage is desirable if it can be moved properly.

This merchandise, being of every kind, size and description, requires careful handling at terminals to avoid breakage and the resultant damage claims. In addition there is equired an extensive floor space to avoid the expense of high tiering, and this means longer distances for the usual hand-trucking, less rapidity in transference and more expense. There is generally an average of feight increase of 100 percent every ten years.

To the above causes are due the continuing expenditures of millions at terminals. If there can be obtained a greater capacity of quay walls, piers and sheds, due to superior equipment for loading, discharging and storing freight, the enormous investments can be greatly reduced.

Terminals sometimes can be enlarged by purchasing more land, but as these terminals are usually located near the business centers of large cities, the excessive cost is often prohibitive, and commerce at many ports has been starved due to the lack of money for necessary enlargements.

This paper is the result of a recent trip of the writer abroad to study terminal conditions, with special reference to sea and river ports, as well as to ascertain the trend of the developments of the different kinds of freight handling machinery, so as to be able to afford facilities for more cars or steamships to be accomodated at existing terminals.

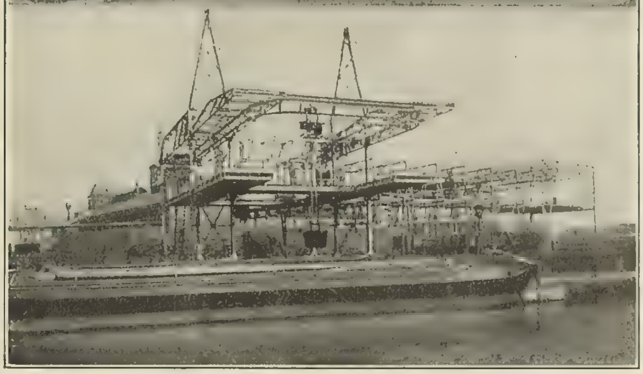

FIG. 3.—OVERHEAD RUNWAY ERECTED ON CONCRETE SUPPORTS. OVERHEAD CARRIERS EQUIPPED WITH ELECTRICAL HOISTS WHEREBY LOADS CAN BE TAKEN FROM THE VESSEL FOR DISTRIBUTION TO SHEDS AT THE REAR OF OF THE PIER

FIG. 4.—HINGED TRACK FOR MOVING CARGOES OF BULK MATERIAL RAPIDLY FROM THE VESSEL TO THE SHEDS IN REAR. MOVABLE TRACKS SERVE CUBICAL SPACE

There was also a desire to be able to recommend such mechanical appliances as would not only merely attain, but which would fully satisfy the conclusion of the Twelfth International Navigation Congress in Philadelphia, as to the mechanical equipment, to which reference is made.

From an acquaintance with terminal operating conditions, and from a study as to the application of standard machinery, it became evident that the greatest capacity at existing terminals could be attained at the least expense by higher tiering by machinery, by utilizing space remote from the front of the quay wall or the pier side, and by a greater rapidity of economical discharging and loading, this latter by removing the drafts of the winch or gantry crane as soon as possible. Any

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such adaptations of machinery should be applicable to the designs of new terminals.

The following conditions were regarded as essential: That the original cost should be low; that the mechanism must be simple, easily and economically operated and with small maintenance cost; that it can be installed without interfering with present operations; that it must involve no new untried machinery.

As pertaining to higher tiering, including distributing and assorting, in the United States and foreign countries, the average height of tiering cargoes is about five feet—that is, as high as one man can readily lift. The reason for this is that where the tiering is higher, say to fifteen feet, the cost of handling is often doubled. It is found cheaper to move the freight many hundred feet horizontally, than five feet more vertically—that is, ten feet—and piling to fifteen or twenty feet is always avoided whenever possible.

If, therefore, any machinery should be found which would distribute, assort and tier over the whole terminal area and do the work rapidly without rehandling by manual labor, thus eliminating congestion, it is evident that the capacity of a pier, or of a transshipment shed or freight house, would be multiplied several times. The importance of the machinery being able to distribute and assort must not be overlooked.

If, instead of tiering five feet, the goods can be raised to twenty feet without additional expense for lifting, then the capacity of the pier or shed would be increased four times; that is, for a given investment, there would be approximately four times the yard, shed or pier capacity. The significance of this is appreciated when the enormous cost of port and other terminals is considered.

Unless such machinery should be able to move the freight to or from any part of the terminal with continuous rapidity, without delays and without rehandling (that is, without congestion), it will not be successful. It is useless to try to achieve mechanical success at terminals and ignore these three principles.

In respect to utilizing areas remote from the quay walls, if such spaces can be served by conveying machinery without rehandling, then less shed or pier space would be required to be reserved for temporary holding or storage, and the areas reserved would provide for placement for the more rapidly unloaded cargo. Similarly, outgoing cargo could be taken from such spaces in less time than it now takes from the usual pier or quay wall shed.

The greater rapidity of discharging is effected by removing the drafts more quickly from the winch or gantry fall-rope. Where gantries are already installed, or where it is desired to use the ship or dock winch, then such machinery would supplement their work.

The mechanism, however, should be able, if preferred, to take the merchandise from the hold or from the deck of a steamship or river barge, or from the side of the pier to any part of the terminal, and also perform the reverse movements.

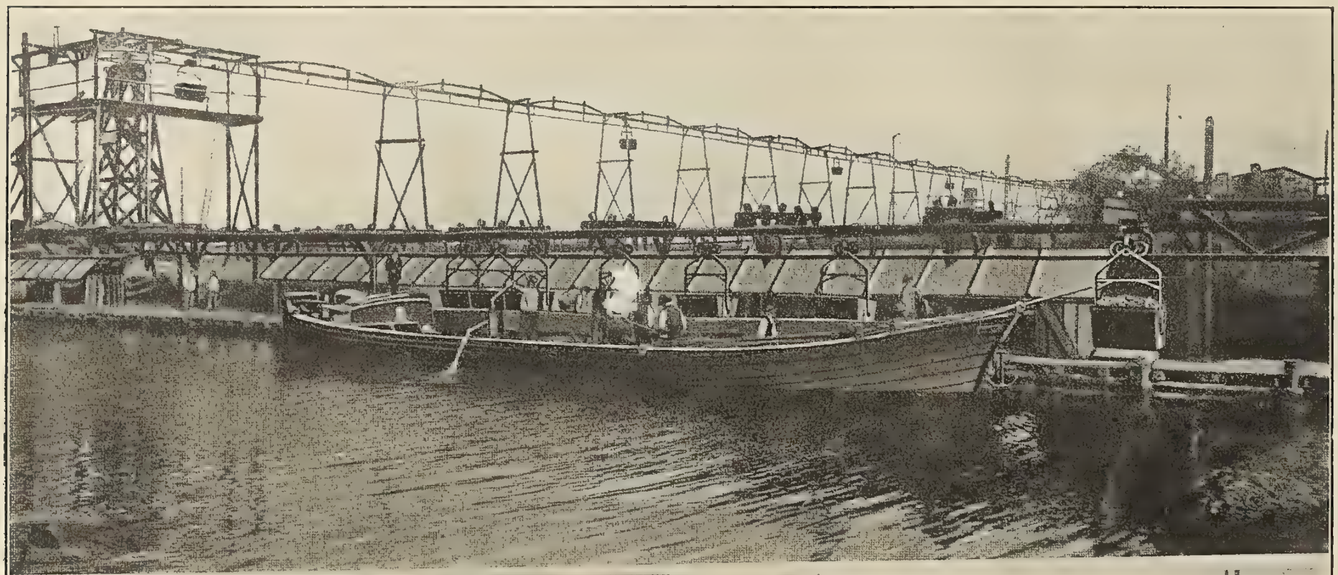


Fig. 5.—Overhead Runways at Different Levels. Six Electric Carriers Over Vessel at the Same Time

Fig. 6.—Movable Tracks for Serving Any Portion of the Yard

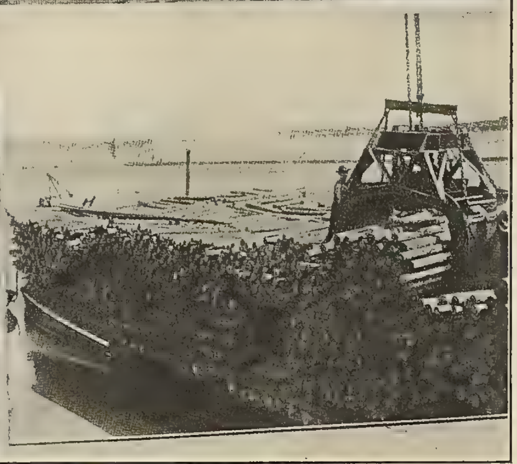


Fig. 7.—Enlarged View of Grab for Unloading Barge

From the above it will be seen that it seemed best to lay emphasis upon the conditions which must be fulfilled by any machinery, and then to find that machinery which would satisfy these conditions.

There are many other conditions which it was most desirable to avoid; as, for example, the occupying by any machinery of floor space which should be reserved for the holding or storage of freight.

It costs only about 3 cents (1½d.) a ton to hoist from the ship's hold to the side of the pier or the quay wall; but the subsequent movements of distribution and assorting to the various parts of the pier shed add nearly 30 cents (1s. 3d.). It, therefore, might be more advantageous to apply the transferring machinery to the terminal distribution, and to utilize the ship's winch or the gantry crane as at present.

The chief difference between the results achieved by the ship's winch and the gantry crane is rapidity. At the foreign terminal ports, especially those of Germany, England, Holland and Belgium, the speed of discharging and loading, so as to secure more voyages for the ships and to utilize to the utmost the working capacity of the quay walls, are the chief reasons for the extensive installations of gantry cranes.

While there may be not so much difference in the speed of hoisting, of the winch and crane, yet on account of the gantry being able to serve a greater area, thus avoiding the congestion caused by the winches at the place of deposition, greater final speed is obtained.

FIG. 8.—TRANSFERRING GOODS FROM HOLD OF VESSEL TO WAREHOUSE. A SWITCH ENABLES LOADS TO BE TRANSFERRED TO OTHER WAREHOUSES. THE BOOM EXTENDING OVER THE VESSEL IS HINGED FOR RAISING TO CLEAR SHIP'S RIGGING

FIG. 9.—MECHANICAL TRANSFER OF MISCELLANEOUS FREIGHT AT RIVER LANDING

From a large number of views, the following have been selected to illustrate a type of transferring machinery installed at several localities, chiefly in Germany. That they are of recent construction indicates the trend of development. Although below each picture is a short description in explanation, yet a reference to the special features of each will serve to illustrate their fulfilling the principles contained in this article.

In Fig. 8 (the upper view) the load is taken from the vessel to the warehouses. The lower picture is an excellent illustration of conveying to remote areas. In Fig. 2 (lower picture) is the moving track serving area at a long distance from the shore. In Fig. 3 the loads are taken from the winch or the gantry to the land area. In Fig. 5 is shown rapidity of movement by many electric cranes. Fig. 6 shows how space is served without rehandling. A short study of these different views will indicate that they will fulfil the conditions described in this paper.

Conclusions

First. The performance of the gantry crane, or of the deck or ship's winch can be supplemented by far-conveying distributing and assorting machinery.

Second. This mechanism can be of the overhead runway type, with movable tracks and with electric traveling conveyors, as now manufactured by German, English, French, American and other manufacturers.

Third. That by high tiering by such machinery there can be a greatly increased capacity of piers, transshipment sheds and storage areas.

Fourth. That there can be secured a greater rapidity in removing from the place of deposition the drafts of cranes and winches, thus avoiding congestion.

The National Character of the Navy

At the annual banquet of the American Society of Naval Engineers, Rear Admiral Robert S. Griffin, chief of the Bureau of Steam Engineering, pointed out in a striking manner the national character of naval work, showing how widely that work is scattered and how eventually the money expended for naval work goes back to all the people and not into the pockets of a small privileged class of men. He said in part:

"To many the building of battleships means the employment of a certain number of men in one of the Atlantic coast shipyards. It never seems to occur to these people that when the building of a battleship commences an impetus is given to trade in many of the States of the Union, and that the work actually done at the shipyard consists largely in assembling material whose manufacture, either as a whole or a part, is scattered over a large part of the country. Our iron ore comes from the great iron ranges of the Northwest, from Alabama and Tennessee, and some from Cuba. The materials necessary for converting the ore into steel material ready for use comes from such other States as Illinois, Pennsylvania, Ohio and Maryland, and nearly all of the steel material is produced in these States. The copper comes from Michigan and Montana, and is made into merchantable material in New York, New Jersey, Massachusetts, Michigan, Ohio and Connecticut. The wood comes from North Carolina, Georgia, California and Oregon. The manufactured articles which are supplied to the builders ready for installation—and they comprise a large portion of what goes to make up what we call a battleship—come from the great manufacturing States of the East, and from Ohio, Indiana, Illinois, Michigan and Wisconsin, and these States draw on others for their raw material, or for their shop equipment and other material necessary for carrying on their business.

"When the ship is completed a change takes place, and the States which had little or no hand in the building of the ship come to the front in furnishing the supplies necessary for the maintenance of the crew and for the operation of the ship. We draw upon the great agricultural States of Illinois, Missouri, Iowa, Kansas, the Dakotas, Minnesota, Nebraska and Texas for corn and wheat products and for meats for provisioning our ships. The cotton belt is in evidence by a considerable outlay for the manufactured articles represented by the product of that part of the country. The bulk of our coal comes from Maryland, Virginia and West Virginia, and some from Pennsylvania. Texas is also the principal source of our supply of oil for fuel, California having, as yet, furnished comparatively little, and Louisiana and Oklahoma still less. Virginia also has something of a monopoly in the supply of manufactured tobacco, though it draws on other tobacco-producing States for the raw material.

"It should be remembered that this 'trade' from the navy is no small item, for while we build only two battleships a year (and sometimes only one), we maintain twenty-one battleships in full commission and a number of others and of inferior vessels in reserve. The food supply alone for the fleet costs annually nearly as much as a battleship without armor and armament, while the fuel costs one-half as much. The other supplies are less in value, but I think I have shown enough to make it clear that the bulk of the money spent on the navy eventually finds its way back to a large majority of the people of the whole country."

Admiral Griffin also made some interesting statements regarding the growth of engineering in the navy during the past twenty-five years. Twenty-five years ago the total horsepower of the navy was then less than 90,000 in ships built. To-day it is nearly 2,250,000, or twenty-five times as much as it was twenty-five years ago, and our most highly-powered ship has engines of 32,000 horsepower against the *Chicago's* 5,000. This enormous increase in the engine power of our ships has, naturally, brought with it a large increase in cost, but the cost has not been in proportion to the power; for while the power has increased twenty-fivefold, the cost of maintenance of machinery has increased only tenfold, notwithstanding a very material increase in the cost of labor.

A glance at what has been done in the past four years will show how economically the engineering side of the navy has been operated. During these four years the horsepower of our ships has increased more than 35 percent—in figures about 562,000, which is equivalent to the power of twenty battleships of the *Delaware* class—and it is a significant fact that the appropriation for the up-keep and operation of that machinery is actually less by $400,000 (£82,000) than it was four years ago.

This means more than appears on the surface. Four years ago a number of our capital ships were out of commission, and the readiness of their machinery for active service was something that would have to be put in the doubtful column in considering the availability of a ship for a sudden call. To-day the machinery of every ship is ready, and those in reserve are capable, on the shortest notice, of proceeding to sea and taking their place with the fleet, without any apprehension on the part of the Department as to their ability to stay there and meet every demand.

Another thing to be taken into consideration in the comparison is that the cruising speed of the fleet is higher, and that the ships are driven harder than ever before, which, of course, means greater wear and tear, and relatively greater cost of up-keep, and it should be a matter of pride that all this is being accomplished for far less than we spent on a smaller navy four years ago.

Argentine Battleship Rivadavia.—The Argentine battleship *Rivadavia* will leave the works of the Fore River Shipbuilding Company, Quincy, Mass., on Aug. 3, and will proceed to New York, where arrangements have been made to dock the vessel in No. 4 drydock at the Brooklyn navy yard, where the necessary under-water overhaul and painting will be completed. The vessel will be taken to the Rockland (Maine) measured mile course about Aug. 11 for her standardization and endurance trials, which, at the request of the Argentine Naval Commission and the contractors, will be conducted by the Board of Inspection and Survey of the United States navy.

New Steamers for Central Vermont Railway

The steamers *Narragansett* and *Manhattan*, for the Long Island Sound service of the Central Vermont Transportation Company between New York City and New England ports, are now rapidly approaching completion at the yards of the builders, the Harlan & Hollingsworth Corporation, Wilmington, Del.

These steamers are of the twin-screw type, and are intended, primarily, for passenger service, although space and handling appliances are also provided for carrying express freight.

They are designed and powered for a speed of 20 miles an hour; for although the schedule to be maintained calls for a speed of only 17 miles an hour, extra power has been provided; so that time can be made up in case of delay by fog or head tides.

The steamers were designed and the construction superintended by Naval Architects Frank E. Kirby and J. W. Millard & Bro., and they are also built to the requirements and under the special survey of the English Lloyds Classification Society, all of which means that they are of the highest possible standard.

The general dimensions of these new vessels are:

	Feet
Length over all	332
Breadth, extreme	66
Depth, molded to main deck	22

The hulls are of steel and, to insure safety in the event of damage, are divided into separate compartments by eight main watertight bulkheads: They are also provided with a cellular double bottom, which is closely divided into separate watertight compartments.

The propelling machinery consists of twin-screw engines, triple expansion, with four cylinders and cranks balanced on the Yarrow, Schlick, Tweedy system to ensure smooth running and freedom from vibration. The indicated horsepower is about 5,000.

There are six boilers of the cylindrical return-tube type fitted with Howden's forced draft, allowed a steam pressure of 185 pounds per square inch, and the up-takes are fitted with cinder catchers of improved design.

Each engine is complete, with its own separate condenser,

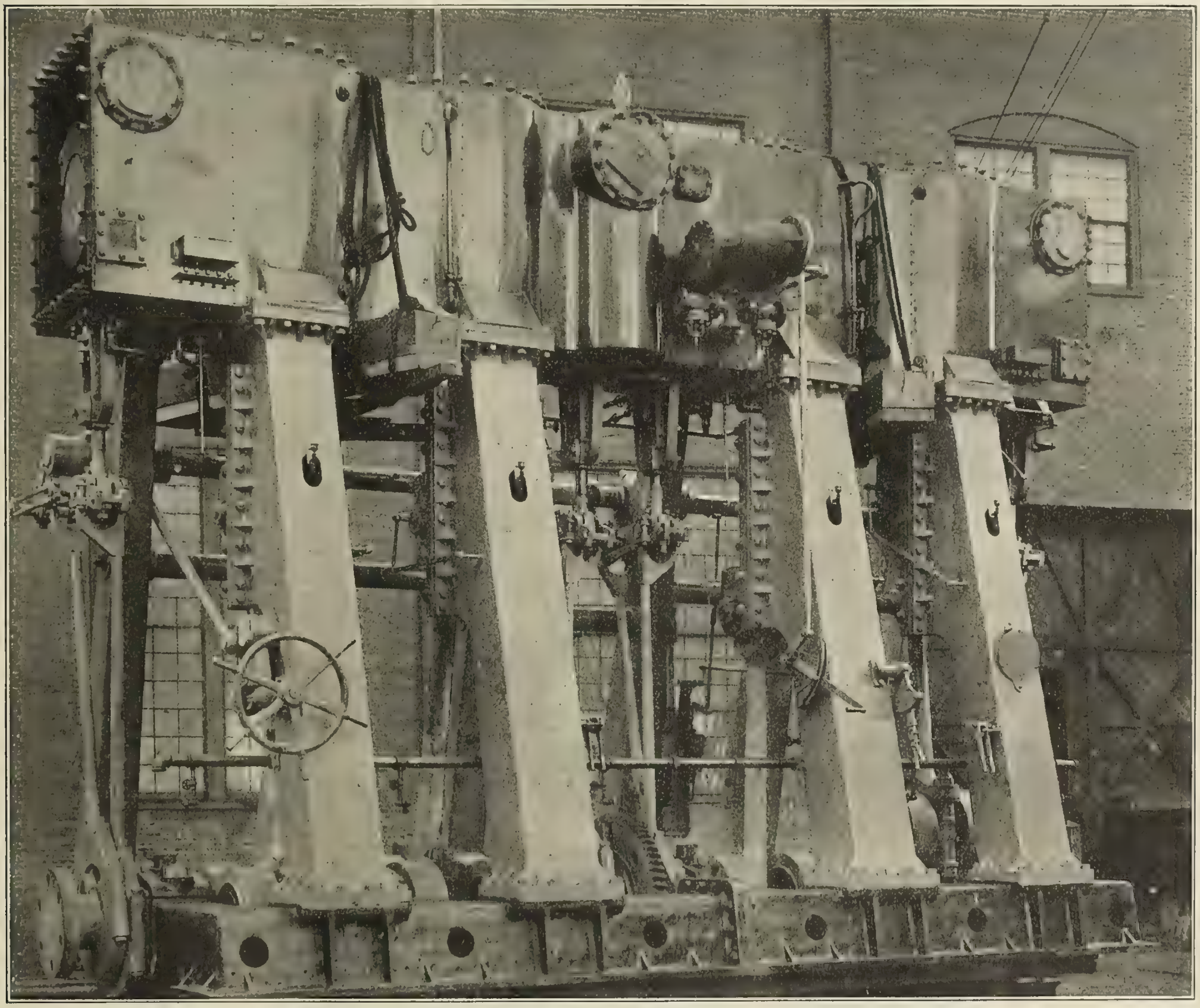


FIG 1.—TRIPLE EXPANSION ENGINE FOR ONE OF THE NEW CENTRAL VERMONT RAILWAY STEAMERS

FIG. 2.—VIEW OF HARLAN AND HOLLINGSWORTH SHIPYARD SHOWING STEAMERS NARRAGANSETT AND MANHATTAN UNDER CONSTRUCTION.

feed, air and circulating pumps, etc.; in fact, the whole power plant is in duplicate, thus practically eliminating any possibility of breakdown.

Most complete provision has been made for the safety and comfort of the passengers.

The dining saloon is on the main deck aft of and connecting with the entrance lobby. The dining room is Colonial in design, with mahogany wainscot and ivory white above.

Two private dining rooms are provided, finished in ivory white with silk panels on the walls. The decking in the dining saloon is of linoleum tiling and the furniture of mahogany.

The entrance lobby is finished in mahogany in the Doric style, and the floor is covered with rubber tiling. At the after end of the lobby is a wide mahogany staircase leading up to the main saloon, and the staircase well is surmounted with a handsome dome, glazed with cathedral glass. At the after end of the main saloon is the music room, finished in white mahogany. Over 100 staterooms connect with the main saloon, including four parlor staterooms with brass beds and with private bath rooms. Immediately above the main saloon is the gallery deck, accommodating 100 staterooms, including parlor staterooms with private bath rooms, same as on saloon deck.

FIG. 3.—STEAMER NARRAGANSETT NEARING COMPLETION

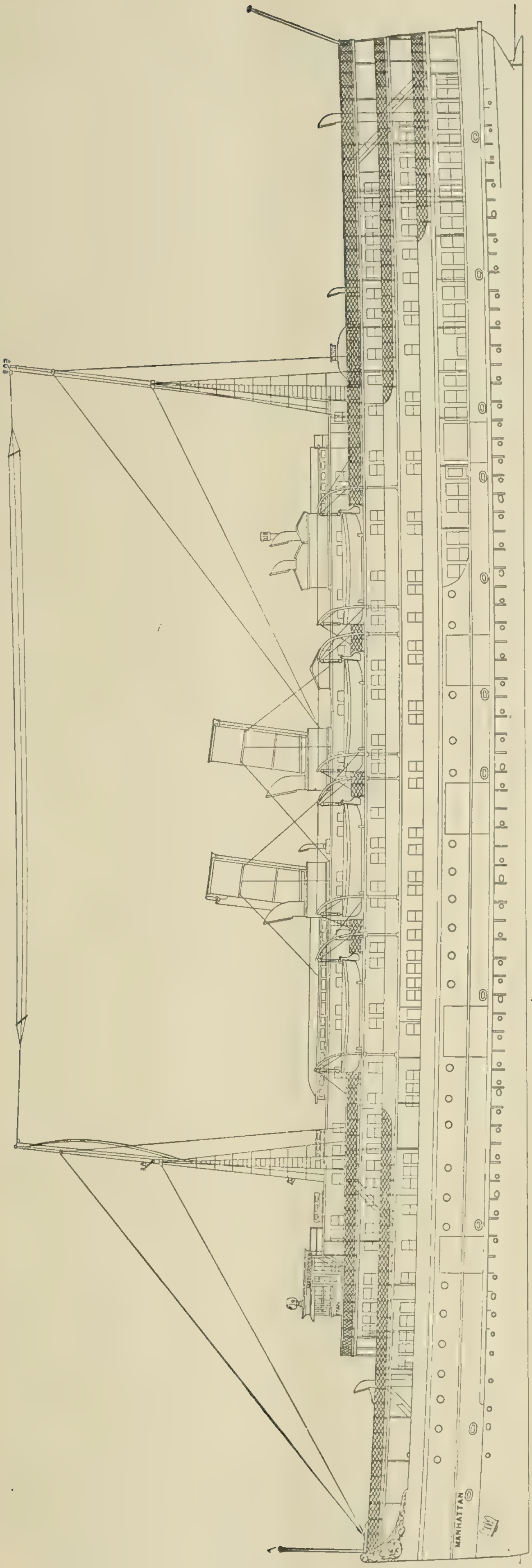


FIG. 4.—OUTBOARD PROFILE OF CENTRAL VERMONT STEAMER MANHATTAN

At the after end on the gallery deck is provided a grill and café, finished in quartered oak. At the forward end of the gallery deck is an observation room with a semi-circular glass front, commanding a fine view forward. The hurricane, or boat deck, besides accommodating forty staterooms, provides a roomy promenade.

A feature is that a large number of staterooms have each a private toilet room with water closet and wash basin, but no bath tub. By dividing the space necessary for one bath room into two toilet rooms a much larger number of staterooms are provided with toilet rooms, and it is believed that this plan will be popular. On each deck there is a large general lavatory for men and one for women, and each stateroom will have its own porcelain wash basin served with running water.

Special mention should be made of the accommodation provided for second class passengers. The line expects to carry a large number of high-class immigrants bound for Canada and the Far West, and quarters have been provided for them far superior to what is usual. The forward parts of the saloon deck, the main deck and the lower deck will be reserved for second class passengers; on the saloon deck will be staterooms with berths, and on the lower deck large, airy cabins with berths providing accommodation for about 150 people. On the main deck will be a lunch room and lavatories for the second class passengers.

The vessel will be brilliantly lighted by electricity, the whole installation being most modern and complete, consisting of three large turbine generating sets and including a large searchlight. There will be a complete system of electric bells, also telephones, and a wireless telegraph will be installed for maintaining communication with the shore.

Particuar attention has been paid to protection from fire. All woodwork through the cargo space is insulated with sheet iron and asbestos, the bulkheads in the crew's and other quarters are of steel instead of wood, the whole main deck is of steel with no wood on it, and all casings extending up through the ship are of steel.

Two fire-resisting bulkheads are provided, extending through all the passenger decks to the dome, dividing the vessel into three fire compartments, and an independent sprinkler system is provided for the cargo spaces and the second class quarters on the main deck. Supplementary to this there is an automatic fire alarm system fitted all through the ship, also fire hydrants in numerous positions on every deck.

A steam heating plant on the vacuum system of capacity to comfortably heat the vessel in the coldest weather has been installed.

Annual Meeting of the Society of Naval Architects and Marine Engineers

The twenty-first general meeting of the Society of Naval Architects and Marine Engineers will be held at 29 West Thirty-ninth street, New York, on Thursday and Friday, Dec. 11 and 12. The annual banquet will be held at the Waldorf-Astoria Friday evening, Dec. 12. Hitherto the usual time of holding the annual meeting of this society has been in November, but this year a later date was chosen in order to accommodate the members and their friends from the Great Lakes. Owing to conditions existing in that region in November many members of the society have been unable to attend the meetings, but by postponing the meeting to a later date it is hoped that a substantial increase in attendance will result and likewise a considerable increase in the membership of the society. An unusually interesting programme of technical papers is being prepared, covering the latest developments in naval architecture and marine engineering, and it is expected that the meeting will prove of particular value and interest.

McAndrew's Floating School

BY CAPTAIN C. A. McALLISTER *

CHAPTER XI (Continued)

Engine Fittings

"Chief," interrupted O'Rourke, "you can't go much further aft without telling us about propellers, can you?"

"For once, O'Rourke, you are right, as that is certainly the next step.

"The subject of propellers is one of the most interesting connected with marine engineering. Volumes have been written about them, and nearly every engineer of any standing in the business has, at one time or another in his career, attempted to invent a new kind that would be far superior to any other propeller ever made. The Patent Office contains about as many propeller designs as there are ships on the seas. About one of these designs in ten thousand is of any practical use, so let me warn you young men never to let your fancies run to the idea that you can invent a propeller.

"The whole science of propeller designing is based on a process of evolution. Do you know what 'evolution' means, O'Rourke?"

"Sure!" said he of Irish extraction. "That means that man is descended from a monkey."

"You have the idea all right, and the modern propeller has about the same relation to the original propeller as a man bears to his original, in accordance to the theory of a certain philosopher named Darwin.

"When propellers were first invented, the idea was that they should be as large as it was possible to have them. A story is told of an old-time coasting steamer fitted with an engine of five or six hundred horsepower driving a four-bladed propeller about 15 feet in diameter. She was ambling up the coast one day at a 6-knot clip when the propeller struck a log; whereafter, as the story goes, she immediately increased her speed to 7 knots. On examination it was found that one of the blades had been broken off, a fact which immediately started the theory that a three-bladed propeller was the proper thing to use. As a matter of fact, the increased speed was undoubtedly due to the reduction in area of an excessively large propeller.

"The best designed propellers of to-day are those built in accordance with data derived from propellers which have been in use. Step by step they have been improved upon until it seems that we have to-day reached a point where but little more improvement can be made. The crude propellers used on the first screw steamers and all propellers used since that time have been useful in developing the modern propeller, as it has been from actual experience, and after very expensive experience, too, that perfection in propeller design has been gradually approached.

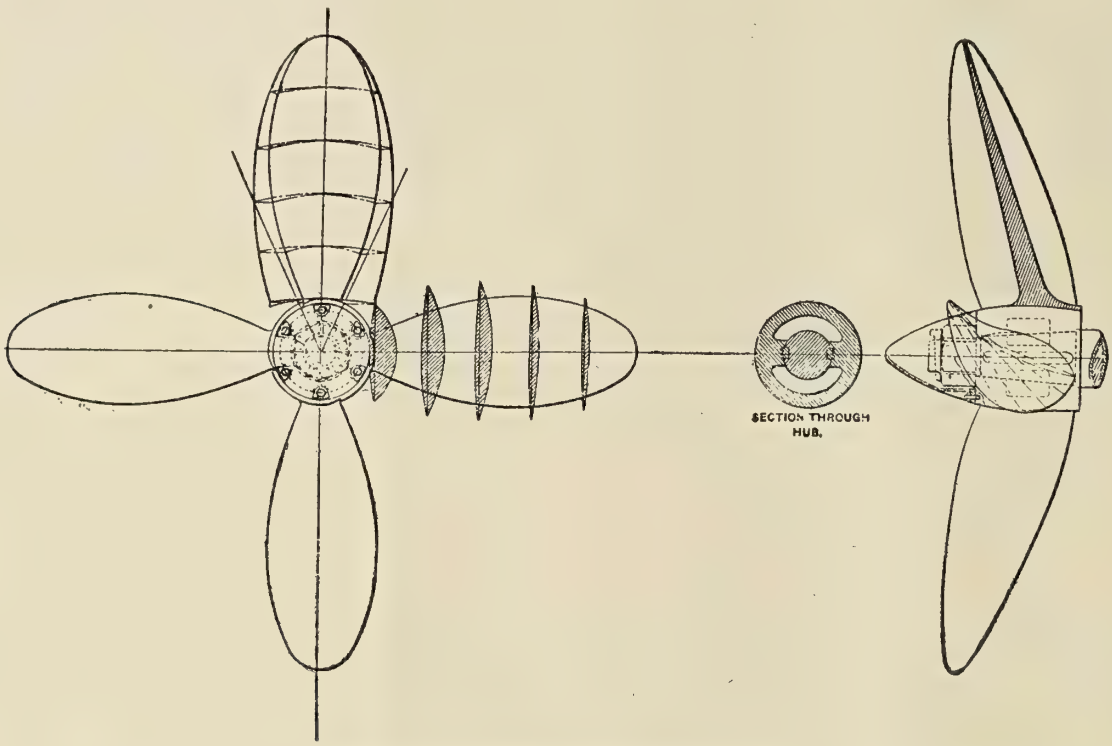


FIG. 21.—SCREW PROPELLER, BLADES CAST WITH HUB

"The results of all these years of experimenting have evolved a standard wheel with uniform pitch and blades elliptical in shape set at right angles to the shaft axis, or slightly raked aft from the perpendicular, according to the individual fancy. The great majority of propellers are now four-bladed, a small portion of them three-bladed, and occasionally we see a two-bladed propeller on an auxiliary vessel.

"Propellers, small in diameter, are almost invariably made solid; that is, the hub and blades are cast in one piece, such as shown in Fig. 21.

"Larger propellers are of the 'built-up' type; that is, the blades and hub are cast separately and the blades are flanged and bolted to the hub. The advantages of this type are that in case any of the blades are broken they can be replaced without throwing away the entire wheel, and, further, that

*Engineer-in-Chief, U. S. Revenue Cutter Service.

by slotting the holes in the blade flanges the pitch can be altered if deemed necessary."

"What material is best for propellers?" inquired Nelson.

"That depends on how much money you have," replied the chief. "In fact it is something like buying underclothes. A poor man buys cotton and it serves the purpose; a man of moderate means buys woolen—that serves the purpose better; a rich man would buy silk, and that is better than any of the others.

"With propellers, cast iron serves the purpose and is cheap; cast steel is stronger and costs a little more; bronze is stronger, smoother and lasts longer, but costs much more than either of the other materials."

"I think Schmidt must wear a cast iron undershirt, judging from the rust he has on it," suggested O'Rourke.

"If shipowners but knew it, polished manganese bronze or other high-class materials would be much cheaper in the end than cast iron or cast steel. A screw driven into wood encounters considerable friction, and you will be surprised to learn that the screw-propeller driven through the water also encounters a great deal of friction. Experiments have shown that from 10 to 20 percent of the total power of the engine is consumed in overcoming the friction of the screw. Hence it pays to have the blades made as smooth as possible to reduce this frictional loss. Recent experiments of rubbing graphite on the blade surfaces demonstrate that an appreciable amount of friction is reduced by means of that lubricant."

"What do they mean by the pitch of a propeller?" asked Pierce.

"McAndrew picked up a bolt that was lying on a bench, and said: "I hold this nut rigid in my hand and turn the bolt head one complete revolution; you will see that the end of the bolt has advanced about 1/16 inch out of the nut—that is what is called the 'pitch' of the thread on the bolt. So with propellers, the pitch is the distance the ship should be driven ahead by one revolution of the screw if it was driven through a solid. But water is not solid by any means, and hence the ship does not advance the distance it should; the difference between what it does advance and what it would advance in a solid is called the 'slip.' This term is always expressed in percentage; for example, if the pitch of the screw is 20 feet, and the ship is driven ahead only 17 feet at one revolution of the engine, the slip is 3 feet, and there would be said to be a 15 percent slip, as 3 is 15 percent of 20."

"How do you tell whether a propeller is right or left-handed?" asked Schmidt.

"The best way to tell that is to imagine yourself in the bottom of the dry dock looking forward at the propeller. When the screw is driving the ship ahead and it turns in a direction corresponding to the motion of the hands of a watch it is called right-handed. If in the opposite direction then it is left-handed.

"The driving face of a blade is not, as you might imagine, the forward side, but the after side, as it is that side which acts on the water; therefore the back of a blade is its forward side."

"That sounds Irish," said Schmidt, glancing at O'Rourke.

"The area of a propeller, sometimes called the helicoidal area, is the sum of the actual areas of all of its blades.

"Later on I will try to show you how to calculate the pitch of a propeller by measing the wheel in position."

CHAPTER XII

Condensers, Air and Circulating Pumps

The repairs to the *Tuscarora* were rapidly nearing completion; the new boilers were in place, much of the connecting piping had been gotten out and the end of the job was in sight. The students of the "Floating School" had not lost interest in their voluntary work, although their regular duties were now much harder than at the commencement of the repairs. McAndrew had looked for his pupils to slacken in their interest in his lectures, but no one had missed a single evening which he had devoted to their instruction. In consequence he had determined to carry the course through for them, and on this particular evening in early March he opened his remarks by saying:

"Well, boys, this work I know is rather dry to you, but later on we will get into something more interesting to you. I propose to cover all the principal parts of marine machinery by these lectures, and then to give you some practical questions on the subject and to show you how various problems are worked out.

"Up to date I have tried to instruct you in a general way as to how steam is generated and how it is utilized to produce power. We now come to the part where, having used the steam, we must get rid of it. This is a step second only in importance to generating the steam. We have seen that by applying heat to water in the boiler steam is formed; the condenser serves directly the opposite purpose, for therein the heat is taken out of the steam and it returns to its original state—water. Some people look at the condensers as if there were something mystifying about its action, but the process of condensation is simplicity itself. The very atmosphere we breathe acts as a condenser, for you no doubt have noticed how readily steam escaping from an exhaust pipe is turned into water simply by contact with the air, and especially is this noticeable on a cold day.

"You might think that in the steam as it leaves the engine there is but little heat left, and as a matter of fact the temperature is only about 110 degrees F.; but you must remember the first principles and realize that the temperature as shown by the thermometer is only the sensible heat. Do not forget that when the water was transformed into steam it took about 934 heat units, known as the latent heat, to bring about this change of state. To turn the steam into water again this latent heat must be taken out in order to accomplish the change, and, approximately speaking, there are 1,000 heat units per pound of steam to be carried off by the cooling water. Herein lies one of the great wastes of any steam plant, and unless the exhaust steam can be utilized for heating the feed water, or for heating buildings in the case of shore plants, there is no way yet devised to prevent it."

"Chief," interrupted Pierce, "I don't understand how this exhaust steam can have so low a temperature as 110 degrees F., when you told us that steam did not form until the thermometer stood at 212 degrees F."

"I see," replied the instructor, "that you did not grasp the idea of water boiling at different temperatures according to the pressure it is under. It is true that under atmospheric pressure it does not form steam until 212 degrees, but as the pressure is reduced the boiling point is lowered accordingly. Steam leaving the low-pressure cylinder of an engine is at an absolute pressure of only a pound or two corresponding to a vacuum of 26 or 27 inches, and if you were to boil water in such a vacuum you would find that steam forms at a temperature of approximately 110 degrees. Hence it is that the exhaust steam has such a low temperature.

"Fortunately the best medium for condensing steam is cool water, so on shipboard the supply of cooling water is, of course, close at hand. The condenser, as the apparatus for bringing about the transformation from steam to water is termed, is made in two principal types for marine purposes. The jet condenser consists of a large cylindrical casting into which the exhaust steam passes, and where it comes in contact with jets of water which transform or condense the steam to water. As the condensing water is used in such large quantities it must be pumped overboard, together with the water of condensation. For vessels sailing on fresh water such a device is cheap, economical and highly efficient, but for vessels plying in salt water where the condensed exhaust steam must be used over and over again for boiler feed, jet condensation is absolutely useless. Hence we have what is known as the surface condenser, wherein the steam does not come in direct contact with the circulating or cooling water.

"Surface condensers are made either cylindrical or rectangular in section, according to the space which they are to occupy. When they are built in the engine framing, as most frequently happens in merchant vessels, they usually have a cylindrical top with flat sides and bottom, strongly ribbed to prevent collapse from the external pressure of the atmosphere. At each end of the condenser there is what is known as a water chest for the entrance and exit of the circulating water. The greater portion of the interior of the condenser is filled with small brass tubes, usually ⅝ inch outside diameter, running lengthwise, and fitting into what are known as tube

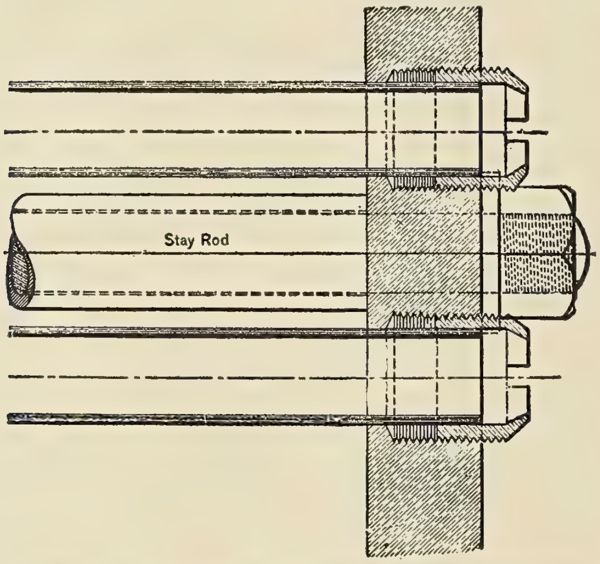


FIG. 22.—FERRULES AND TUBE PACKING IN SURFACE CONDENSER

sheets, one at each end of the condenser. These tubes are spaced very closely together, and through them flows the cool sea water. The exhaust steam as it enters the condenser thus comes in direct contact with the outer surface of these small tubes and is quite readily transformed into water. In order to prevent the steam from striking the tubes in one spot directly opposite the exhaust pipe, it is customary to fit a perforated baffle plate opposite the opening for the exhaust, which baffle plate scatters or deflects the steam along the entire length of the tubes. It is, of course, highly essential that the condenser be kept as tight as possible, for if there are any leaks the salt circulating water will be forced into the body of the condenser, where it will mix in with the condensed steam and find its way into the boilers. Hence great care must be exercised in packing the ends of the innumerable small tubes. Fig. 22 will show you how these tube ends are made tight.

"Holes are tapped in the tube sheets into which are screwed small glands known as ferrules, and the packing space is usually filled with corset lacing."

"Gee!" exclaimed O'Rourke, "they ought to carry lots of girls on ships to furnish all that corset lacing."

"You will notice," continued McAndrew, "that the ends of these glands or ferrules are beaded over slightly. That serves the purpose of preventing the tubes from crawling out of place on account of the contraction and expansion due to the varying temperatures to which these long, slender metal tubes are subjected. It also allows them to expand without starting to leak, as would otherwise be the case.

"If condenser shells are cylindrical in shape it is usual to make them from rolled steel plate, but if they are of rectangular section they are almost invariably made of cast iron. The tube sheets are always made of composition. The tubes themselves are made either of brass or Muntz metal, usually coated outside and inside with tin, although many designers do not think that this tinning process is now necessary. At the water ends, particularly, where iron and brass are in such close proximity, it is very important to see that a sufficient amount of zinc plates is suspended in the water to prevent galvanic action. Some careful engineers also have zinc plates fitted in baskets in the fresh-water side of the condenser for the same purpose, although these are not so essential there as in the water chests.

"This evening as I was coming into the engine room I noticed you boys looking around the main condenser, so I supposed you were trying to study its connections."

"Yes," replied O'Rourke, "Schmidt was trying to find how the air got into the air pump when there is only steam goes into the condenser."

"I suppose," replied McAndrew, "that the air gets in the air pump just about the same way that water gets in the milk we buy at the corner grocery—it's put in. The term 'air pump' is really a misnomer; to be sure, there is a small amount of air gets into the condenser with the steam, but the main function of an air pump is to pump the condenser water out of the condenser, and incidentally any air and vapor that may be there.

"Air pumps on board ships are, as a rule, vertical, and of two general types, connected and independent. By 'connected' we mean that they are worked through the medium of beams from one of the crossheads of the main engine, usually the low pressure. The principal advantages of this arrangement are the certainty of action so long as the engine is running and the economy of operation, as the power is, of course, furnished by the main engine, which is generally of the most economical multiple-expansion type. Its disadvantage is that there is no vacuum while the main engine is not running. This, however, is not great, as the vacuum is produced almost at the first stroke of the main engine.

"An 'independent' air pump is one that is driven by its own steam cylinders; and as a rule this type is uneconomical, as the economy of operation is only equivalent to that of a slow-running simple engine. There is an advantage, of course, in always having a vacuum in the condenser whether the main engine is running or not. Unless an independent air pump is of very good design and kept in good order, there is always a likelihood of its stopping at the most inopportune times. In this they closely resemble a mule who will work along all right until, perhaps, when crossing a railroad track, he will get balky just as a train is coming along."

"Do you start a balky pump the same way that you would start the mule?" inquired Pierce.

"Very much the same," replied McAndrew. "I once had an Irish oiler with me who would occasionally get mad when the air pump stopped, and would strike it on the valve chest with a top-maul. Very frequently the pump would start off immediately on being given that treatment, probably because the jar would start the controlling valve which had stuck. However, I do not recommend such strenuous treatment of balky pumps, and you had better not let me catch any of you striking pump valves that way on board this ship.

"The air pump itself is usually of the same design, whether operated independently or attached to the main engine. Fig. 23 will show you the type usually adopted for marine work.

"Air pumps are always attached to the very lowest part of the condenser, so that the water of condensation will flow to the pump by gravity. In the sketch you will note that the pump is not unlike any ordinary style of pump for pumping liquids. The valves form the main distinguishing feature. There are, as you will see, three sets of these valves; the ones at the bottom being termed 'foot valves,' those in the piston are known as 'bucket valves,' and the set of valves at the top are 'discharge valves.'

"The method of operation is that as the bucket or piston starts on its upward stroke a vacuum is produced in the pump barrel, which, when it overcomes the vacuum in the condenser, causes the water, air and vapor to rush through the foot valves into the body of the pump. On the down stroke the contents of the pump are in turn discharged through the bucket valves, and on the following up-stroke are forced through the discharge valves at the top, whence they go to the hot well or feed tank. You will notice that the top plate on the pump which contains the discharge valves is not bolted to the pump in this sketch, but is held down by a large spiral spring. This is what is known as a floating top, and it is thus arranged so as to allow the ready escape of a large volume or gulp of water which is liable to pass through the pump at any time. Quite often pumps which have not been provided with bucket on a large mass of water which could not escape quickly a floating top have had the top broken by the impact of the enough through the small valves. Most large air pumps are made of cast iron, fitted with a thin composition liner. The bucket should be of composition, and the top and bottom valve plates should also be made of the same material.

"The air pump valves nowadays are usually made of several light bronze disks of decreasing diameters, the largest diameter being at the bottom. These are held down by light bronze wire spiral springs. Some engineers, however, still prefer vulcanized rubber valves.

"You will notice that the bucket shown in this sketch has a number of grooves turned in its rim; these are supposed to trap small quantities of water and thus prevent leakage from one side to the other. Ordinarily buckets of this kind are fitted with bull rings and packed with square hemp packing, as that is much more reliable than the so-called water packing.

"Pumps above 18 or 20 inches in diameter are usually fitted with a manhole in the side of the barrel, so as to provide ready access to the bucket and foot valves without removing the top and the bucket as well whenever it is necessary to examine the lower sets of valves.

"What pump on board of a ship do you think has the easiest job?" inquired McAndrew, trying to test the knowledge of his pupils.

"I know," quickly said O'Rourke, "it's the pump in the firemen's washroom when Schmidt is taking a bath—he's afraid of water."

"I haven't heard of any pump handles being broken when you were taking a bath, either," retorted Schmidt.

"Well, you will have to decide the bathing proposition yourselves," remarked McAndrew. "But what I wanted to call to your attention is the fact that the circulating pump, a very important adjunct of marine machinery, has comparatively little hard work to do. In condensing the exhaust steam a very large quantity of circulating water is used, as for every pound of steam condensed there is required under ordinary conditions the cooling effect of about 30 pounds of sea water. Thus for a 4,000-horsepower engine, using about 16 pounds of steam per horsepower each hour, there would be required about 3,800 gallons of circulating water per minute. This water has, however, only to be pumped with sufficient force to overcome the friction through the tubes and the small head due to forcing it overboard a few feet above the pump. The requisite force is so small that on fast torpedo boats there is a scoop arrangement at the in-take which, when the vessel is going at full speed, is sufficient to drive the circulating water through the condenser without the help of the pump.

"The pump almost universally used for circulating purposes is of what is known as the centrifugal type—with the accent on 'trif' and not on the 'fug,' as I have heard some of you boys pronounce it. By the way, does any of you know the meaning of 'centrifugal?'"

Not even O'Rourke ventured a reply, so McAndrew informed his hearers that "'centrifugal' means 'flying from the center,' the opposite effect, or 'flying towards the center,' being expressed by the word 'centripetal.' A pump of the centrifugal type is therefore one in which the water entering at the center is driven outward by a revolving series of blades called the 'runner,' and is discharged through an opening in the casing which is connected by a pipe to the condenser. This is an ideal type of pump for circulating the water through the condenser, inasmuch as a large quantity of water can readily be handled at a small expenditure of power. Pumps of this description are ordinarily operated by a single-cylinder engine

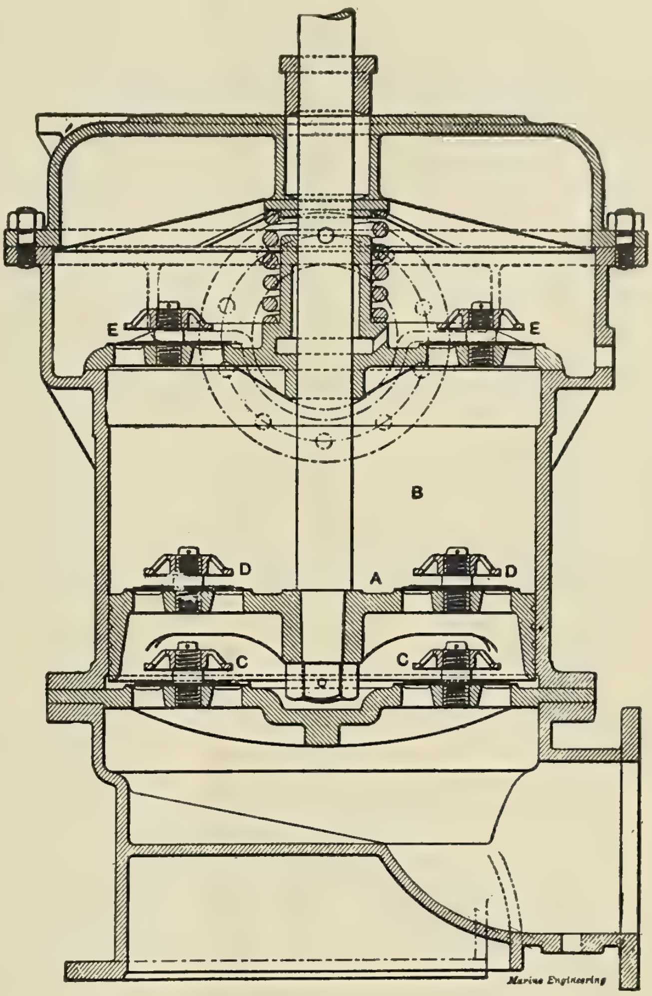


FIG. 23.—VERTICAL ATTACHED AIR PUMP

of the usual type. An extension of the crankshaft of the engine forms the shafting for the pump runner, and inside the pump casing this shafting is usually encased in composition. The runner is generally cast of composition, but with the exception of small pumps the pump casing is made of cast iron, in halves, flanged and bolted together. Pumps of this description need but little attention, as there are no valves to get out of order as is the case with the ordinary types of reciprocating pumps. Being of such an advantageous type, centrifugal feed pumps are now used on shipboard to a limited extent, little difficulty being encountered in forcing water into a boiler against a pressure of as high as 200 pounds. Feed pumps of this description are driven by small steam turbines."

"Suppose the circulating pump should break down, how would you keep running?" inquired the observing Nelson.

"There is very little possibility of such an accident occurring, but it is a wise thing to prepare for even so remote an emergency," answered McAndrew. "I have seen some ships fitted with a special discharge pipe from the fire pump or the auxiliary feed pump to the water end of the condenser. I know of one ship in particular where the casing of the circulating pump collapsed on account of excessive corrosion on the inside. The chief engineer was a resourceful fellow, and fitted two hose connections to the small handhole plates on the water chest of the condenser; then by connecting up two lengths of fire hose to the fire main and running the auxiliary feed pump, he managed to keep sufficient vacuum in the condenser to run the engine along at half speed, and the ship got safely into port."

"Suppose your air pump busted, what would you do?" asked O'Rourke, not to be outdone in asking questions by his mates.

"Even the permanent disabling of the air pump need not put the engine out of business," replied the Chief. "If worse came to worse, you could take down the main exhaust pipe, rig up a temporary pipe out of heavy canvas, and exhaust to the atmosphere—tugboat fashion. Many steamers have a suction pipe connecting the channel-way under the air pump direct to the main feed pump. By this method the condenser can be kept clear of water, and a fair amount of vacuum maintained.

"You will find, as you live longer, that the application of good common sense and some ingenuity will help you out of many difficulties which at first seem insurmountable. These attributes are possessed by almost every marine engineer, as the very nature of his business requires a liberal use of both of them. Those are the qualities which make marine engineers the best operating engineers for any type of machinery."

(*To be continued.*)

Performance on Service of the Motor-Ship Suecia*

BY I. KNUDSEN

In the autumn of 1911 the Rederiaktiebolaget Nordstjernan Company, of Stockholm, ordered six motor liners from Messrs. Burmeister & Wain, the dimensions of the vessels being as follows: Length, 362 feet; breadth, 51 feet 3 inches; depth, 34 feet; carrying capacity, 6,500 tons deadweight.

The machinery consists of two main engines, each of 1,000 indicated horsepower (four-cycle Diesel engines with eight cylinders), besides two auxiliary Diesel engines, each of 200 effective horsepower, for working the compressors, auxiliary machinery (such as winches and steering gear), and for the production of the electric light; the machinery is in other respects similar to that of the *Selandia*, which was described by the author in a paper read before this Institution last year.[1]

As to passenger accommodation, there are only eight cabins for first class passengers, which is much less than is provided for in the *Selandia;* the cabins, however, are roomy and modern, and provided with bath and toilet rooms. Further, there is ample saloon accommodation, and a hospital. The *Suecia* is intended for the Sweden to La Plata service, and she will be chiefly employed for cargo purposes, being fitted with the most modern loading and discharging gear, such as double derricks and double winches.

The vessel was launched on Nov. 2, 1912, and the trial trip took place on Dec. 17, 1912. The next day she went to Limhamn, where she took in a cargo of 15,000 barrels of cement, then she sailed to Stockholm, where—as far as I know—a cargo of 4,000 tons was taken in. On Dec. 23 she left for Gothenburg, and here she took in still more cargo, and left on Dec. 31, arriving at Christiania on Jan. 1, where her cargo was completed, and on Jan. 4 a trial trip took place in the Christiania Fjord with the vessel fully laden. When the trial trip had been completed she went to London, where she arrived on Jan. 9, and went from London to Rio Janeiro, arriving at that port on Feb. 1.

I will refer to certain matters concerning the *Suecia* owing to some remarks made in the discussion of the paper which was read before the Institution of Naval Architects, to the effect that no information was given with regard to the efficiency of the propellers, etc., compared with that of ordinary steamers. The reason why no such information was given in connection with the *Selandia* was, that with this vessel no

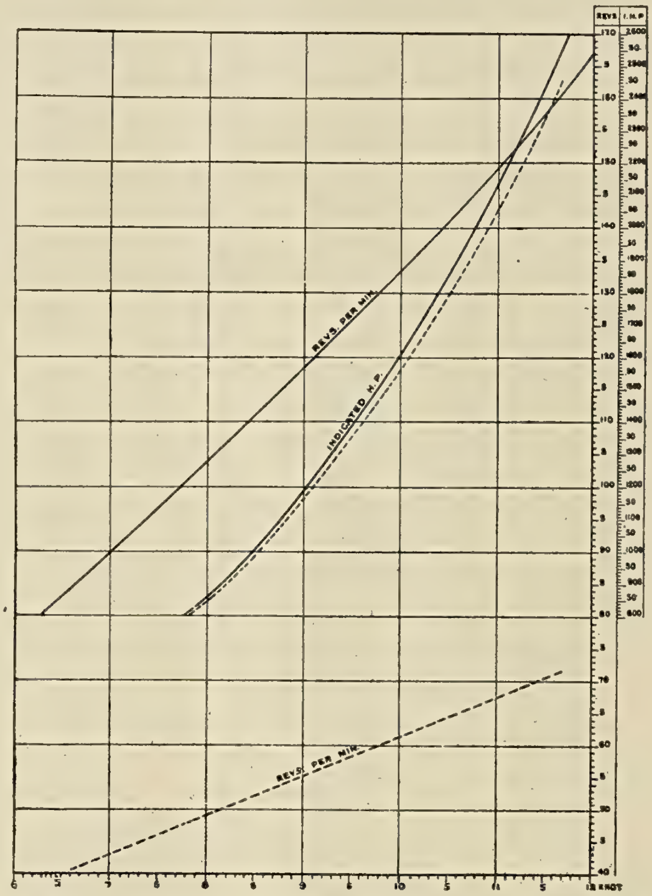


FIG. 1.—M. S. SUECIA (FULL LINES), 362′ × 51′ 3″ × 23′ (DRAFT), D. W. 6,500 TONS, COEFFICIENT 0.78; S. S. PRINCESSAN INGEBORG (DOTTED LINES), 360′ × 48′ 9″ × 22′ 4″ (DRAFT), D. W. 5,895 TONS, COEFFICIENT 0.794

trial trip took place with the ship fully laden, and consequently we possessed no comparative results. With the *Suecia,* however, we succeeded in carrying out this trial trip in Christiania Fjord, and I am glad to have this opportunity of publishing the results.

The full lines on Fig. 1 give the curves showing the indicated horsepower, the number of revolutions and the speed obtained with the *Suecia.* The dotted lines on this figure give similar particulars obtained with the *Princessan Ingeborg,* a vessel built a few years ago for the same owners, but fitted with steam engines.

As appears from the dimensions given on these diagrams, the vessels are almost alike, both in dimensions and also with regard to the fineness of lines. If the two vessels are compared it will be seen that to obtain the same speed for the same displacement the same indicated horsepower is required, whether it is to be used in the motor liner or in the steamer. According to this result, there seems to be no difference in the power required to propel a vessel, whether this is effected by means of a single, large, slow-running propeller, as in the

* Abstract of a paper read before the Institution of Naval Architects, Glasgow, June, 1913.

[1] Trans. I. N. A., Vol. LIV, p. 68.

steamer, or by two relatively fast running small propellers, as in the motor liner. The propeller in the steamer has a diameter of 17 feet 6 inches, and in the motor liner of 10 feet.

In this respect it must be remembered that in the *Suecia* the main Diesel engines do not work the pumps nor the two first stages of the air compressors. The relation of the indicated horsepower to the brake horsepower of the engines will, therefore, be about the same as in a steam engine, and the combined efficiency of the mechanism of the engines and of the propellers is about the same as obtains with the steam engine. The weight of steam installation in the *Princessan Ingeborg* brought up to correspond with the horsepower of the motor

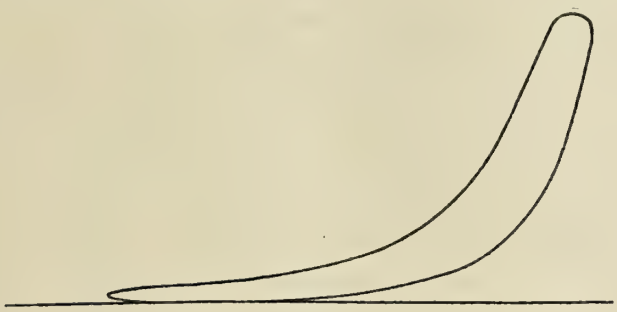


FIG. 2.

installation amounts to 570 tons, as an extra main boiler was fitted in view of the cleaning of the boilers. The total machinery in the motor ship *Suecia* weighs 470 tons. With regard to the space occupied by the engines in the *Suecia*, this is 41 feet of the length of the vessel, whereas it is 66 feet in the *Princessan Ingeborg*, although the horsepower as stated above is less in this vessel.

It should be stated that the trial trip took place under good conditions, such as fine weather and deep water. The vessel, however, has now returned from her maiden voyage, and from the speed attained on the Atlantic the comparative trial trip results seem to hold true in the practical performance of both vessels.

In the trial trip in Christiania Fjord the oil consumption per indicated horsepower-hour was measured, and a result was obtained which no doubt is the best hitherto obtained, viz., 134 grams of oil per indicated horsepower-hour, measured on the main Diesel engines, and when everything is allowed for, such as the consumption of the auxiliary engines, etc., the oil consumption per indicated horsepower of the main Diesel engines amounts to 154 grams, including the fuel oil necessary for the working of the auxiliary engines, steering engines, pumps, etc., but exclusive of the oil used for heating the vessel. The mechanical efficiency of Diesel engines of the type used, but with the whole of the compression of the air necessary for fuel injection performed by the engines themselves instead of by auxiliaries, has been shown by bench trials to be 80 percent, so that the oil consumption per brake horsepower of such a marine Diesel engine would amount to 167½ grams per brake horsepower.

The diagram, Fig. 2, which was taken during the trial trip, shows by its shape and appearance that the engine is extremely economical.

BUILDING FUND OF THE INSTITUTE OF MARINE ENGINEERS.—A site for the permanent home of the Institute of Marine Engineers has been secured on Tower Hill, London, and building operations will soon be commenced. The sum of £12,000 will be required for the completion of this project. Half of this amount has already been subscribed, and it is hoped that the general appeal of the Institute for donations to this project will be met with a ready response by firms and individuals interested in shipping, shipbuilding and marine engineering.

On the Trials of Three Ferry Steamers Propelled by Geared Turbines*

BY J. INGLIS

The following paper is offered in response to a suggestion from Dr. Archibald Denny during the discussion on Sir Charles Parsons' paper read at the spring meetings. Dr. Denny expressed a wish to have the results of the trials of three small vessels fitted with geared turbines, but at that time these trials were incomplete.

The vessels are named *Curzon, Elgin* and *Hardinge,* after three Viceroys of India, and are intended to connect Ceylon with the Indian mainland by a short sea passage in smooth water instead of the long and occasionally disagreeable voyage which hitherto has been the only available means of transit.

The South Indian Railway Company, owners of the vessels, applied for guidance to the late Sir William H. White, who furnished them with an outline design of the internal arrangements and a specification covering all the requirements of the service, at the same time leaving the builder a very free hand as to the form of the vessel, scantlings of material, power of propelling machinery and other details.

Sir William White's foresight was evinced by the fact that the whole contract has been completed without any alterations on the working plans or any extra charges of importance. The vessels are 250 feet long by 38 feet broad, and displace about 865 tons on 6 feet draft of water.

The principal conditions of the contract were that the vessels should carry 160 tons of deadweight on a draft of water not exceeding 6 feet, and while so loaded be capable of steaming 20 sea miles at the rate of 16½ knots, starting from rest, no allowance being made for the time occupied in getting under way. The fuel used on trials was to be as nearly as possible equivalent in heating power to the Indian coal available on service, a sample analysis being furnished which showed 63.26 percent of fixed carbon. The coal actually used contained 63.86 percent of fixed carbon, being a rather poor sample of Scotch coal, but almost exactly what was wanted. Yarrow boilers were fitted, the heating surface being 7,000 square feet and the grate 168 square feet. The boilers were arranged to be fired with oil if that should be found advantageous.

It will be observed that the actual full speed to be attained was not stated in the conditions, nor were any data available whereby it might be computed. It was considered safe to assume 17 knots, and estimates were made on that basis, as if 17 knots could be maintained for 19 miles there would be left 1 mile of distance and over five minutes of time to attain full speed. This was deemed to be sufficient.

A preliminary trial of the *Curzon* was made on Dec. 10 last to test the working of the turbines, and the weather being very calm advantage was taken of the divisions on the measured mile in the Gareloch to learn something about the acceleration of a vessel starting from rest. The results are shown on the diagrams. Fig. 1 shows, on a base of one nautical mile, the time for each fraction of a mile and the increasing speed during acceleration. Fig. 2 shows, on a base of speed in nautical miles per hour, the revolutions of propellers, the slip in knots and the slip percent during acceleration. Fig. 3 shows the revolutions, slip and shaft horsepower during a progressive trial of the *Elgin,* also the effective horsepower (which Messrs. Denny were so kind as to ascertain for us in their experimental tank) and the ratio of effective to shaft horsepower.

The dotted curves on Fig. 1 show the computed speed during acceleration, also the time required to run 1 mile starting from rest. These were constructed by Mr. Mumford, superintendent at Messrs. Denny's experimental tank, from calculations based

* Abstract of a paper read before the Institution of Naval Architects, Glasgow, June, 1913.

on the resistance of the model. The agreement between the curves constructed from calculations made on a model and those from experiment on a full-sized ship is extremely close.

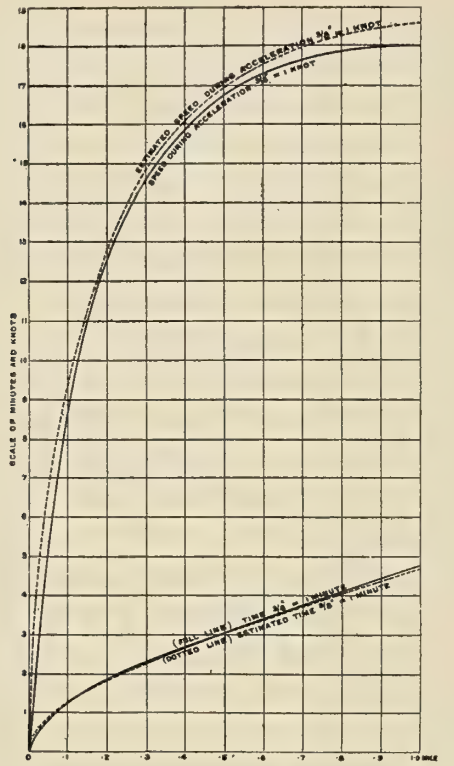


FIG. 1.—T. S. S. CURZON; DOTTED CURVES BY TANK TRIAL, FULL CURVES BY OBSERVATION

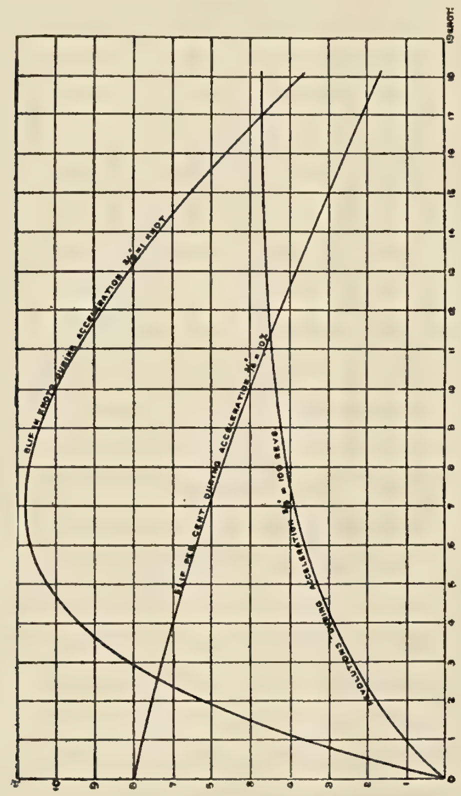


FIG. 2.—T. S. S. CURZON; CURVES ON SPEED BASE

The 20 miles distance, starting from rest, was steamed by the *Curzon* in 65 minutes, equal to a mean speed of 18.46 knots, the tide being with her for the first half and against her for the second half, the wind fresh, about three points abaft the beam. The time occupied by the *Hardinge* was 66½ minutes, equal to 18.045 knots, she having a stiff breeze against her and a weak tide in her favor, high water at Greenock being about 8 o'clock on that day. It was not considered necessary to repeat this trial with the third vessel, and instead of this a progressive trial was made on the measured mile, and a run of two hours at high speed was utilized in measuring the water consumption.

During the latter the revolutions were somewhat reduced by a strong head wind, the average being 482.8 per minute, corresponding to a speed of 17.8 knots. The mean shaft horsepower was 2,390, and the consumption of steam, for turbines only, 12.55 pounds per hour per shaft horsepower. The consumption of steam by the auxiliaries amounted to nearly 3 pounds per hour per shaft horsepower of main engines. Among the auxiliaries are reckoned the engine driving a large dynamo and the steam steering gear. The temperature of the feed was 205 degrees F. The air pressure in the stokehold did not exceed a quarter of an inch of water column.

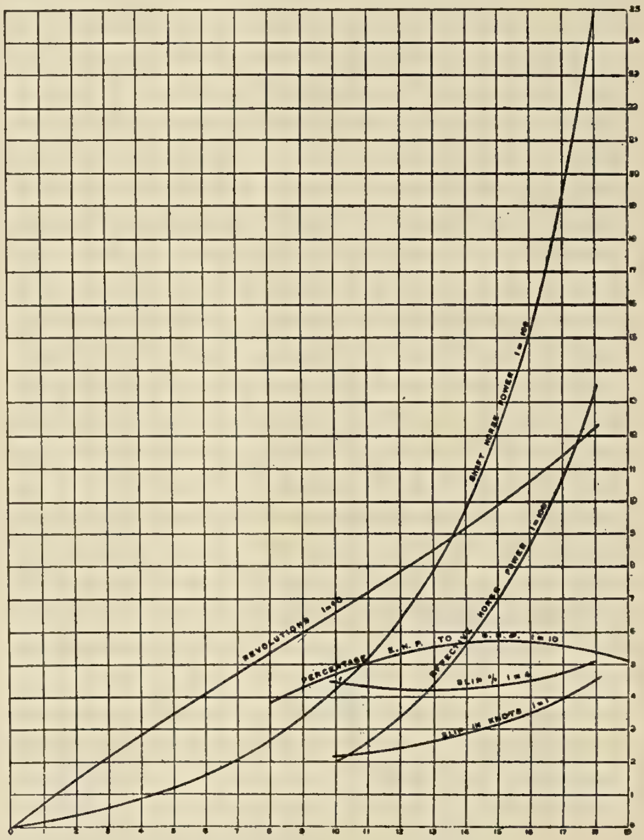


FIG. 3.—PROGRESSIVE TRIAL RESULTS

An attempt was made to record the noise of the gearing on a new phonograph obtained for the purpose; but, although the sound of the engine room telegraph gong and some vocal efforts were clearly rendered by the instrument, the sound of the gearing could not be recognized amid the scraping of the reproducer on the wax cylinder.

Professor Biles, in his interesting remarks on Sir Charles Parsons' paper, quotes a shipowning friend repelling the suggestion to permit the innovation of "cog-wheels" in a passenger steamer's propelling machinery. The use of cog-wheels cannot be regarded as a novelty even in high-class ocean-going passenger steamers. I can remember the building, in 1855, of the steamer *Oneida,* which was then deemed large, seeing that only twenty-five steamers of the same or greater register tonnage were on the Mercantile Navy List at that date. This vessel was 307 feet long by 39 feet beam. Her gross tonnage was 2,284, and her net register 1,372 tons. Her engines were direct-acting, but the results were so unsatisfactory that before she was two years old, that is, in 1857, she was put into our hands to undergo certain alterations and receive new geared engines of about 3,000 horsepower. These engines, cog-wheels and all, appeared to work satisfactorily for seventeen years, though I fear they could not have been remarkable for economy of steam, and in 1875 she was converted into a sailing ship. Thirty years later, being then fifty years old, she disappeared from the British register, having found a new owner in Chili.

High speed of piston being somewhat of a bugbear to engineers in the fifties, geared engines were common enough in channel and coasting steamers, and even Robertson's frictional gearing, where the wheels and pinions had grooves in place of teeth, was not unknown in marine work. What was tolerated sixty years ago, with cast iron pinions and mortise wheels, might surely be adopted now with the refined methods of gear cutting which Sir Charles Parsons and others have made available.

Contract for New Mallory Liners.—An order has been placed with the Newport News Shipbuilding and Dry Dock Company, Newport News, Va., by the Mallory Line for two new passenger steamships of 7,000 gross tons each. The new vessels will be 432 feet long overall.

Note on Some Cases of "Fatigue" in the Steel Material of Steamers*

BY S. J. P. THEARLE

Evidences of what is known as the "fatigue of metals" have from time to time been disclosed when surveying steel vessels under repair, but during the last year or two certain phenomena of the kind have been observed which possess special features, and it is thought that these may be of interest to the members of this Institution.

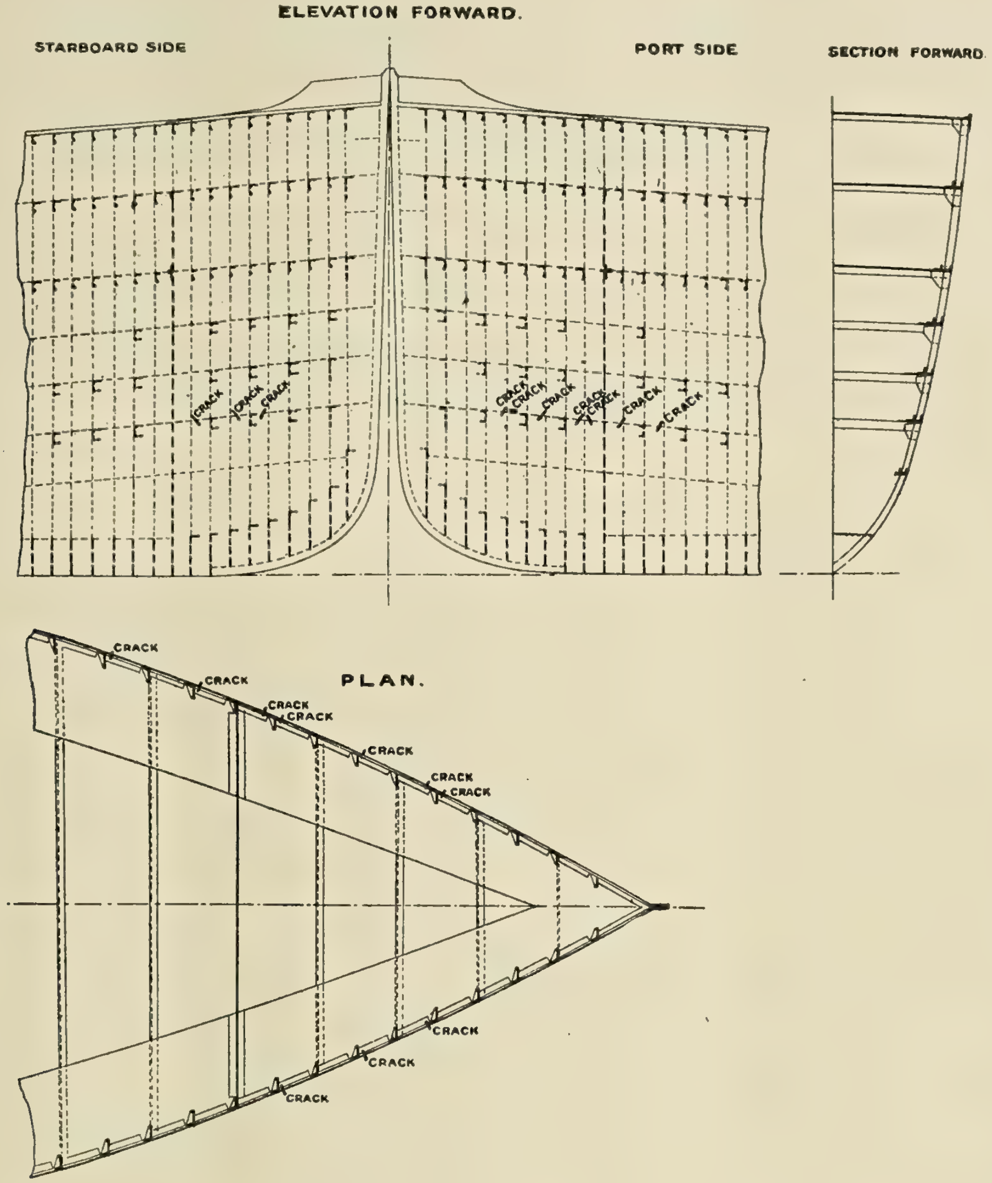


FIG. 1

In the first of these cases which came under notice a crack was observed in the shell plating on each side of a vessel a short distance forward of the collision bulkhead. These cracks extended right through the plating, and from the amount of wasting by corrosion which had taken place within the cracks it was evident that they were not of recent date. The cracks were of irregular form and did not break into rivet holes, nor were they near the edges of the plating. Soon afterwards another such case occurred, except that in this instance the cracks were at some short distance abaft the collision bulkhead. Then another and yet another case came under atten-

* Abstract of a paper read before the Institution of Naval Architects, Glasgow, June, 1913.

tion, so that surveyors at certain repairing ports began to look out for them when vessels came under survey. It was evident from the first to experienced surveyors that the symptoms were similar to those due to fatigue in the steel, such as had been observed at some other parts of vessels.

It was remembered that some twenty years ago similar cracks were sometimes seen in margin plates of double bottoms at the backs of the angle-bar attachments of the frame heel brackets. Leaks in the margin plate had led to the removal of the attachment angles, and then it was found that cracks had developed in the margin plate at the backs of these bars, in the vicinity of the uppermost rivet and sometimes near the rivet next to it. Such cracks were rarely joined to the rivet hole, but generally they partially encircled it, and it may be mentioned that they were mostly confined to No. 1 cargo hold.

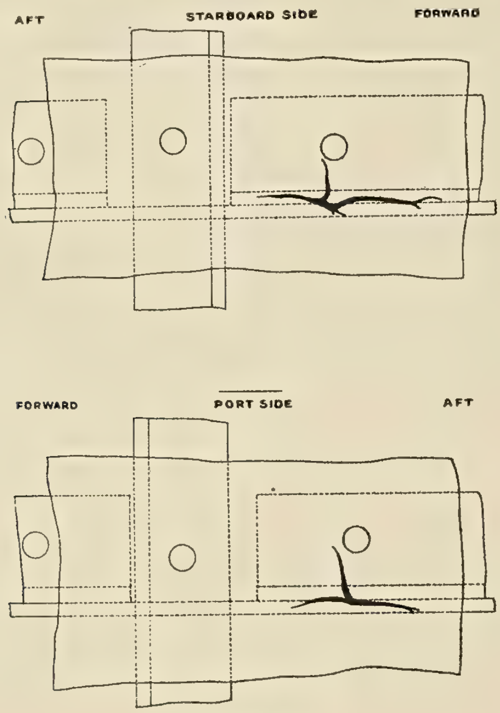


FIG. 2

Careful investigation showed that the cracks were the result of fatigue in the material of the margin plates, due to frequent alternating pull and push stresses brought upon the margin plate by the heels of the frames, and continued over a long period of time. The remedy was found in giving the frame heels a better connection to the double bottom, and this was effected by using double instead of single angle attachments at the margin plates, and by the more extensive use of gusset plates and angles in connecting the frames to the inner bottom plating. Instances of fatigue at this part of a vessel are not often seen at the present day, the remedies adopted having proved to be efficient for the purpose.

The cases in which the phenomena now under consideration had been observed were, therefore, analyzed, and it then appeared that they had certain features in common which pointed to a common cause, and consequently suggested a common remedy. It will be of interest to mention here that up to the date of writing this note about twenty-nine vessels have been found when under survey to have been affected in this way. These are all steamers, ranging from about 3,000 tons to about 5,000 tons gross register. Their ages, when they came under survey, ranged from two to sixteen years, the average age being about nine years. They are of all types, ranging from single-deck to three-deck, spar-deck and shelter-deck vessels, and some have web framing, while others are framed with the deep frames ordinarily adopted at the present day. There is nothing, therefore, as regards type of design or system of framing common to the vessels, but all of them are of steel. Moreover, they are the products of thirteen different builders and seven different building ports.

Fig. 1 shows the bow portion of the profile of one of the vessels, which may be taken as a sample of the total number. The same figure shows a sectional view of the vessel in way of the cracks, and also a part plan of the vessel. Fig. 2 shows some of the cracks on an enlarged scale.

From the positions of the cracks found in the shell plating of these vessels certain features will be apparent, and these, it may be remarked, are common to all cases. These features are as follows:

(1) The cracks are always found either in the forepeak or in the forepart of No. 1 cargo hold.

(2) They always occur at the back or at the edge of a chock angle attachment of a side or panting stringer plate to the shell plating.

(3) They always occur in close vicinity to a frame unsupported by a panting or other beam, and they never occur in the vicinity of a frame which is supported by beams.

This statement suggests at once the cause and the remedy. The primary cause is evidently slight local movement, frequently repeated and extending over a long period of time; and this slight local movement is also evidently due to something which distinguishes the frame at which it occurs from the adjacent frames; that is to say, in being unsupported. It will be observed by referring to the sketch that there cannot have been any panting in the structure itself, for the number of tiers of beams and panting stringers quite preclude such from taking place. The slight movement referred to has occurred only at the intermediate frames between those to which the beams are attached. Note also that, as in the case of margin plates, the crack occurs at the backs of the attachment angles but not at the rivet holes. The fatigue in the plate resulting in a crack seems, therefore, due to a slight but frequently repeated movement in the plating at the chock angle attachment. This suggests the necessity for securing the intermediate frames to the panting stringer and for distributing the resistance to panting stresses over a larger surface of shell plating. By attaching the intermediate frames (unsupported by beams) to a wide stringer plate by means of substantial brackets, and by substituting double for the single chock angle attachments of the stringer to the shell plating, it is hoped that an efficient remedy has been found for this trouble.

It may be added that both in the cases of fatigue at margin plates and in those described in this paper, tensile and other tests made upon material cut from the vicinity of the cracks do not show any abnormal conditions, but simply give the ordinary test results of good, mild steel used for shipbuilding purposes. This would seem to show that the effects of fatigue are practically limited to the small portion of the material which yields under its influence.

Launch of a Steel Screw Steamer at Stockton

On July 4, Messrs. Ropner & Sons, Ltd., Stockton-on-Tees, launched from their shipbuilding yard a steel screw steamer, christened the *Baldersby*, of the following dimensions, viz.: Length, 358 feet 6 inches; breadth, 50 feet 10 inches; depth, 25 feet 8 inches. The vessel will be classed 100 A-1 at Lloyd's, having main deck, poop, long bridge and T. G. forecastle. The appliances for loading and discharging cargoes expeditiously are very complete, and include ten steam winches, double derricks to each hatch, steam being supplied by a large donkey boiler, working at 100 pounds pressure per square inch. The engines will be of the triple-expansion type, by Messrs. Blair & Company, Ltd., Stockton-on-Tees, of about 1,500 indicated horsepower, having two steel boilers 16 feet by 10 feet 6 inches, 180 pounds pressure of steam.

The Deflection Method of Calculating the Strength of Columns and Stanchions—II

BY A. J. MURRAY

THE PARTICULAR CASE OF A STANCHION STAYED AGAINST A LATERAL PULL AT THE HEAD

In Fig. 5 a diagram of such a stanchion is shown, the forces being indicated. Suppose P is the total lateral pull at the head, then for equilibrium P = horizontal component of the resistance of the stays + the elastic resistance to bending the column.

If T = tension in stay.
F = elastic resistance of column.

Then by Fig. 5

$$P = T \; Sin \; \alpha + F \qquad \text{(I)}$$

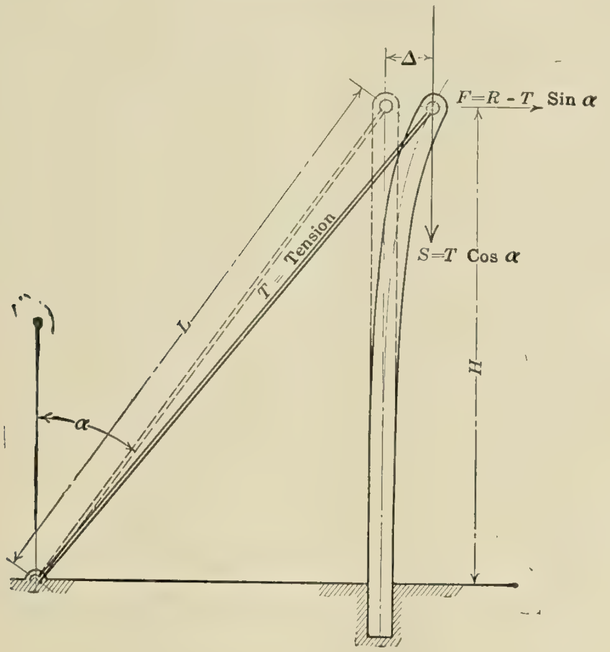


FIG. 5

For a small horizontal deflection Δ of the top of the stanchion, we have to a first order of small quantities.

$$T = \frac{\Delta \; Sin \; \alpha}{L} E_0 \qquad \text{(II)}$$

Where E_0 = coefficient of elasticity of stay and L = length of stay, the downward thrust on the stanchion is

$$T \; Cos \; \alpha = S \text{ (say)} \qquad \text{(III)}$$

Taking Δ as the deflection of the stanchion head, then the bending moment at a section, distant x from the foot, is given by

$$M_x = F\,(h - x) + S\,(\Delta - y) = EI \frac{d^2 y}{dx^2}$$

where h = height of column.

The general solution is

$$y = A \; Cos \; nx + B \; Sin \; nx - \frac{Fx}{S} + \frac{Fh}{S} + \Delta$$

$$\text{where } n = \sqrt{\frac{S}{EI}}$$

To find the constants A and B

when $x = o$, $y = o$ therefore $A = -\left(\frac{Fh}{S} + \Delta\right)$

and when $x = o$, $\frac{dy}{dx} = o$, therefore $B = \frac{F}{Sn}$

When $x = h$, $y = \Delta$

$$\text{Therefore } \Delta = -\left(\frac{Fh}{S} + \Delta\right) Cos \; nh + \frac{F}{Sn} Sin \; nh + \Delta$$

$$\text{or } \Delta = \frac{F}{Sn} tan \; nh - \frac{Fh}{S}$$

$$\text{or } F = \frac{S\,\Delta}{\frac{tan \; nh}{n} - h} \qquad \text{(IV)}$$

Taking T = ultimate strength of the stay, then S is given by (III), *i. e.*, $S = T \; Cos \; \alpha$

Δ is given by (II), *i. e.*, $\Delta = \frac{LT E_0}{Sin \; \alpha}$

and $n = \sqrt{\frac{S}{EI}}$.

So that F is given by IV, and thus the greatest allowable pull is given by *I*, i. e., $P = F + T \; Sin \; \alpha$.

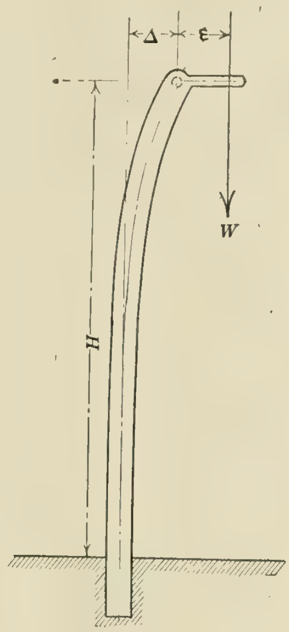


FIG. 6

We have proceeded on the basis of the maximum stress in the stay, and to find the necessary strength of the stanchion we have, bending moment at foot

$$M_0 = S\,\Delta + Fh.$$

If f is the ultimate strength of the column and A the area,

$$\text{then } f = \frac{S}{A} + \frac{Y}{I} M_0$$

$$= \frac{S}{A} + \frac{M_0}{Z} \qquad \text{(V)}$$

where Z is the modulus of the section of stanchion.

A method which is not absolutely rational, but gives the result in a more handy form, is as follows:

Consider the deflection curve to be one of versed sines

$$\text{i. e. } y = \Delta\left(1 - Cos \frac{\pi}{2h} x\right)$$

$$\left\{ \text{where } x = o,\; y = o,\; \frac{dy}{dx} = o \right.$$

$$x = L,\; y = \Delta.$$

So that equation I is true at the cardinal points. Taking S and T as before, then

$$M_x = EI\frac{d^2y}{dx^2} = S\left[\Delta - \Delta\left(1 - Cos\frac{\pi}{2h} x\right)\right] + F\,(h - x)$$

$$= S\,\Delta\; Cos\frac{\pi}{2h} x + F\,(h - x)$$

and integrating out

$$F = \frac{3\Delta}{h^3}\left(EI - \frac{4sh^2}{\pi^2}\right)$$

and the maximum bending moment is

$$M_e = \frac{3\Delta}{h^2}\left(EI - \frac{4sh^2}{\pi^2}\right) + S\Delta$$

Therefore,

$$M_0 = \frac{L\,T}{E_0 \, Sin\,\alpha}\left(\frac{3\,EI}{h^2} - \frac{12\,T\,Cos\,\alpha}{\pi^2} + Cos\,\alpha\right)$$

So that if f = ultimate strength of the column material, and Z = modulus of section at foot, then

$$f = \frac{T.Cos\,\alpha}{A} + \frac{L\,T}{E_0 Z\,Sin\,\alpha}\left(\frac{3\,EI}{h^2} - \frac{12\,T\,Cos\,\alpha}{\pi^2} + Cos\,\alpha\right)$$

This expression gives at once a relation between the strength of stanchion and strength of stay, so that having either the scantlings of the stanchion or stay, we can proceed to make the other of equal breaking strength, so that neither be too strong nor too weak.

Another advantage of this latter method is that if the cross section is not uniform we can set up a curve of $\frac{M_x}{I}$ and carry out the process of integration graphically.

In such cases as a stayed derrick, the pull of the topping lift can be resolved into its horizontal and vertical com-

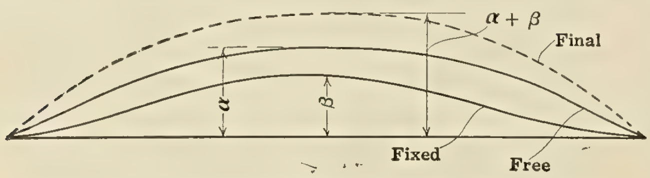


FIG. 7.—A + B EQUALS DEFLECTION AT MIDDLE OF FINAL CURVE

ponents and by adding the vertical component to the force S in the above expression, the method of procedure would then be exactly as described for the case of a horizontal pull above.

The Particular Case of an Unstayed Stanchion Bearing a Load on the Top

Assuming, as in the case of round-ended columns, that there is an eccentricity of loading, we have (Fig. 6):

$$\frac{d^2y}{dx^2} = M_x = W(\Delta - y) + W\epsilon$$

where ϵ = eccentricity of loading, Δ = deflection of top of stanchion.

Integrating as before, $y = A\ Cos\ nx + B\ Sin\ nx + W(\epsilon + \Delta)$

$$\text{where } n = \sqrt{\frac{W}{EI}}$$

whence $\Delta = \epsilon\,(Sec\ n\,L - 1)$.

Taking p as the direct stress due to load only, and f the maximum fiber stress, then

$$f = p\left(1 + \frac{y\epsilon}{\gamma^2}\,Sec\ n\,L\right)$$

$$\text{or } Cos\ R\sqrt{\frac{p}{E}} = \frac{y\epsilon}{\gamma^2}\cdot\frac{p}{f - p}$$

It should be noted that if we here put $\epsilon = o$, we obtain

$$R^2 = \frac{\pi^2}{4} \times \frac{E}{p},$$

which is Euler's expression for an ideal column fixed at the foot and unsupported at the head.

In many cases the eccentricity ϵ has a definite value, being, in fact, the overhang of the load. For instance, in the case of a davit, if we suppose the curved portion replaced by a right-angled bend then both the deflection and stress are given by the above expressions. Usually the deflection of boat and other davits is not figured out, but we find that for some modern warship davits the horizontal deflection at the top reaches some 3 or 4 inches. With such an elastic deflection the whipping would cause the load to be exceedingly lively.

Fixed Ended Columns

Euler's formula for fixed ended columns gives much too high results, and the length for which the formula becomes practicable is much greater than that for free ends. It can therefore only be considered as of theoretical interest, and as giving the limiting value for the load for very high values of $\frac{L}{\gamma}$.

Rankine's formula for fixed ended columns is derived from Euler's formula in the same way as for free ended columns, and gives a fair approximation but no satisfactory means of passing from one material to another.

Moncrief's formula for fixed ended columns cannot be considered as satisfactory, as the eccentricity factor has no meaning at all, since eccentricity of loading does not increase the bending moment at the middle of a fixed ended column.

Further, no respectable column would agree to contort itself into the weird curve he derives by joining up three separate parabolas.

If it is impossible to exactly centralize the load; it is equally impossible to absolutely fix the ends of a column.

Let us suppose, then, that the constraint is not absolutely perfect, and that the deflection curve may be taken as composed of a curve of versed sines, with a superimposed curve of sines, the former taking account of the constraint and the latter of the small degree of freedom.

Fig. 7 shows the method of obtaining the deflection curve. The tangents at the ends will be slightly inclined to the axis.

Let $y_1 = \beta\,Sin\,\frac{\pi}{L}\,x$

represent sine curves.

$$y_2 = \frac{\alpha}{2}\left(1 - Cos\,\frac{2\pi}{L}\,x\right)$$

curve of versed sines. The final curve is given by

$$y = y_1 + y_2 = \frac{\alpha}{2}(1 - Cos\ 2\,n\,x) + \beta\ Sin\ n\,x$$

$$\text{where } n = \frac{\pi}{L}$$

The total deflection at the middle is given by

$$\Delta = (\alpha + \beta).$$

The tangent at the bottom $(x = o)$ is given by

$$\frac{dy}{dx} = n\,\beta.$$

At the top

$$(x = L) \text{ by } \frac{dy}{dx} = -n\,\beta.$$

If M_0 is the bending moment at ends, due to constraint, then

$$M_x = Wy + M_0,$$

$$\text{or} - EI\frac{d^2y}{dx^2} = W\left[\frac{\alpha}{2}(1 - Cos\ 2\,n\,x) + \beta\ Sin\ n\,x\right] + M_0$$

$$\text{Intergrating} - EI\frac{dy}{dx} = W\frac{\alpha}{2}x + M_0\,x - \frac{W\alpha}{4\,n}\,Sin\ 2\,n\,x - \frac{W\beta}{n}\,Cos\ n\,x + A$$

$$-EIy = \frac{W\alpha\,x^2}{4} + \frac{M_0\,x^2}{2} + \frac{W\alpha}{8\,n^2}\,Cos\ 2\,n\,x - \frac{W\beta}{n^2}\,Sin\ n\,x + A\,x + B$$

$$\text{where } x = o \begin{cases} y = o \text{ therefore } o = \frac{W\alpha}{8\,n^2} + B \text{ or } B - \frac{W\alpha}{8\,n^2} = -\frac{W\alpha\,L^2}{8\,\pi^2} & (1) \\ \frac{dy}{dx} = n\,\beta \text{ therefore } E\,I\,n\,\beta = -\frac{W\,\beta}{n} + A.\ A = \frac{W\,\beta}{n} \\ \qquad - E\,I\,n\,\beta & (2) \end{cases}$$

$$\text{when } x = L \begin{cases} y = o.\ o = \frac{W\alpha L^2}{4} + \frac{M_o\,L^2}{2} \div \frac{W\alpha}{8\,n^2} + A\,L + \beta & (3) \\ \frac{dy}{dx} = -n\,\beta.\ \ E\,I\,n\,\beta = \frac{W\alpha L}{2} + M_o\,L + \frac{W\,\beta}{n} + A & (4) \end{cases}$$

$$\text{when } x = \frac{L}{2} \begin{cases} \frac{dy}{dx} = o;\ \ o = \frac{W\alpha L}{4} + \frac{M_o\,L}{2} + A & (5) \\ y = \Delta, -E\,I\,\Delta = \frac{W\alpha L^2}{16} + \frac{M_o L^2}{8} - \frac{W\alpha}{8\,n^2} - \frac{W}{n^2} + \frac{AL}{2} + \beta & (6) \end{cases}$$

From (1), (2) and (5):

$$\frac{M_o\,L^2}{8} + \frac{AL}{2} = \frac{W\,\beta\,L}{4n} - \frac{W\,\alpha\,L^2}{16} - \frac{E\,I\,n\,\beta\,L}{4}$$

Substituting n (6):

$$-E\,I\,\Delta = \frac{W\,\alpha\,L^2}{16} - \frac{W\,\alpha}{8\,n^2} - \frac{W\,\beta}{n^2} - \frac{W\,\alpha}{8\,n^2} + \frac{W\,\beta\,L}{4n} - \frac{W\,\alpha\,L^2}{16} - \frac{E\,I\,n\,\beta\,L}{4}$$

$$\text{or } E\,I\,\Delta = \frac{W\,\alpha}{8\,n^2} + \frac{W\,\beta}{n^2} + \frac{W\,\alpha}{8\,n^2} - \frac{W\,\beta\,L}{4\,n} + \frac{E\,I\,n\,L\,\beta}{4}$$

$$= \beta\left(\frac{W}{n^2} - \frac{W\,L}{4\,n} + \frac{E\,I\,n\,L}{4}\right) + \alpha\frac{W}{4\,n^2} \qquad (7)$$

If in (7) we put $\alpha = o$, we get Euler's expression for free ends, *i. e.*, $W = \frac{E\,I\,\pi^2}{L^2}$, and if we put $\beta = o$, we get Euler's expression for fixed ends $W = \frac{4\,E\,I\,\pi^2}{L^2}$.

$$\text{Sine } \alpha + \beta = \Delta$$
$$\alpha = \Delta - \beta,$$

and we have.

$$E\,I\,\Delta = \beta\left(\frac{W}{n^2} - \frac{W\,L}{4\,n} + \frac{E\,I\,n\,L}{4}\right) + \frac{W}{4\,n^2}\,(\Delta - \beta)$$

$$\text{or } \Delta\left(E\,I - \frac{W}{4\,n^2}\right) = \beta\left(\frac{W}{n^2} - \frac{W\,L}{4\,n} + \frac{E\,I\,n\,L}{4} - \frac{W}{4\,n^2}\right)$$

$$\text{or } \Delta = \frac{\beta\left(\frac{W}{n^2} - \frac{W\,L}{4\,n} + \frac{E\,I\,n\,L}{4} - \frac{W}{4\,n^2}\right)}{E\,I - \frac{W}{4\,n^2}}$$

Substituting the value $n = \frac{\pi}{L}$

$$\Delta = \frac{\beta\left(\frac{3}{\pi^2} + \frac{E\,I\,\pi}{W\,L^2} - \frac{1}{\pi^2}\right)}{\frac{4\,E\,I}{W\,L^2} - \frac{1}{\pi^2}}$$

or putting

$$\frac{L}{i} = R$$

$$\Delta = \frac{\beta\left(\frac{2}{\pi^2} + \frac{E\,\pi}{p\,R^2}\right)}{\frac{4E}{pR^2} - \frac{1}{\pi^2}}$$

$$= \frac{\beta\,(2\,p\,R^2 + E\,\pi^3)}{4\,E\,\pi^2 - p\,R^2} \qquad (8)$$

If f be the maximum compression fiber stress at the middle section of column when p is the average load per unit area, then

$$f = p + \frac{M\,y}{I}$$

$$= p + \frac{y}{I}\,W\,\Delta = p + \frac{y\,p}{\gamma^2}\,\Delta$$

and substituting the value of Δ from equation (8),

$$f = p\left[1 + \frac{y}{\gamma^2}\ \beta\left(\frac{2\,p\,R^2 + E\,\pi^3}{4E\pi^2 - p\,R^2}\right)\right]$$

$$\text{therefore}\left(\frac{f}{p} - 1\right)(4\,E\,\pi^2 - pR^2) = \gamma\,(2\,p\,R^2 + E\,\pi^3)$$

$$\text{where } \gamma = \frac{y\,\beta}{\gamma^2}$$

$$\left(\frac{f}{p} - 1\right)4\,E\,\pi^2 - E\,\pi^3 = \gamma\,2\,p\,R^2 + p\,R^2\left(\frac{f}{p} - 1\right)$$
$$= R^2\,(2\,\gamma\,p + f - p)$$

$$R = \sqrt{\frac{E\,\pi^2\left[\left(\frac{f}{p} - 1\right)4 - \gamma\,\pi\right]}{2\,\gamma\,p + f - p}} \qquad (9)$$

If γ is put equal to zero, then this expression for the stress p returns to Euler's for fixed ends.

For mild steel columns of 60,000 pounds, experiment gives $\gamma = .32$.

$$R = \sqrt{\frac{2961\left[4\left(\frac{6-p}{p}\right) - 1\right]}{.64\,p + (6 - p)}}$$

p being in units of 10,000 pounds.

Proposed Memorial to the Late Sir William White

A meeting was recently held at the Institution of Naval Architects, with Sir Philip Watts, K. C. B., F. R. S., in the chair, to consider what steps should be taken to establish a memorial to the late Sir William White. Representatives of the principal engineering and allied institutions with which Sir William White was connected attended this meeting, and it was resolved to form an influential general committee representing the naval and merchant services, as well as the engineering profession, in order to carry out the object in view. Promises of financial support and communications relating to the proposal will be gladly received by Mr. R. W. Dana, M. A., the secretary of the Institution of Naval Architects, 5 Adelphi Terrace, W. C., who is acting as honorary secretary to the provisional committee.

Accident to the Louisiana

The bravery of the engine room crew of the battleship *Louisiana* helped the vessel out of a dangerous predicament July 2, when a valve bonnet blew off, flooding the starboard engine room.

The battleship was in Narragansett Bay overhauling her engines. The rush of the sea through the passage opened by the displacement of the bonnet carried men off their feet and forced them against the machinery, but they stuck to their work.

The call for collision drill was sounded, bringing every man aboard ship to quarters and automatically closing the bulkhead doors. A collision mat was put overboard, mattresses and blankets were brought into use, and waste in large quantities was jammed into the hole, but all to no avail.

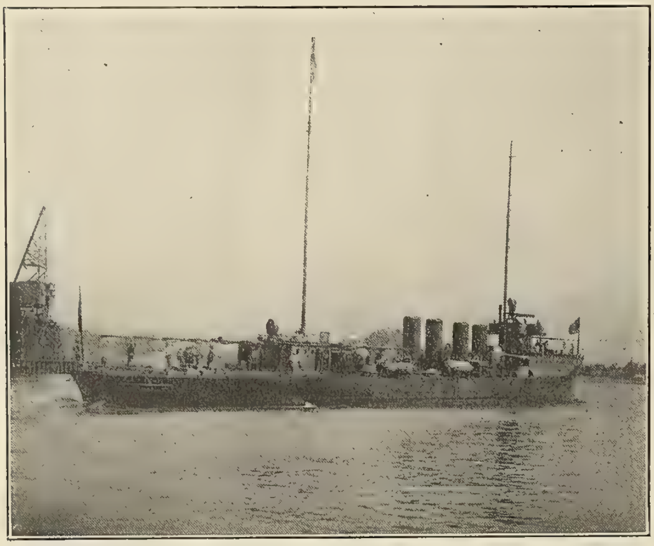
Finally the pumps began gaining on the water in the room, and the battling engine-room force was able to cram into the hole a waste can, heavily packed. This was backed securely, and the threatening water was stopped.

When the accident occurred the battleship was without steam, only one boiler being in use for minor purposes, while the engines were being overhauled.

As a result, tugs had to be called upon to tow the *Louisiana* to a position well inshore. So close was the battleship to the beach that it was reported on shore that she had actually been run upon the sand. Later through the efforts of a diver a new bonnet was placed on the auxiliary overboard discharge valve, through which the water had rushed, the engines were started, and the battleship steamed back to her station without help. —*Army and Navy Register.*

United States Destroyer Duncan

The United States torpedo boat destroyer *Duncan,* 305 feet 3 inches long over all, 30 feet 6 inches beam, fitted with Curtis turbines, developing 16,000 horsepower on twin screws, recently left the works of the builders, the Fore River Shipbuilding Company, Quincy, Mass., for the navy yard, Boston, where she was placed in drydock for overhauling preparatory

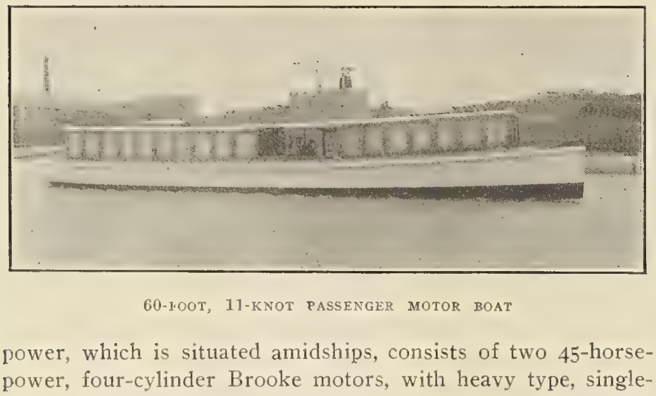


DESTROYER DUNCAN LEAVING BUILDER'S WORKS FOR TRIAL RUNS

to her standardization trials, which began on July 5 over the Rockland (Maine) course. For the purpose of improving the economy under cruising conditions a compound reciprocating engine is connected by means of a removable clutch to the forward end of the turbine shaft. The steam after passing through the engine exhausts into the turbine, which acts as a low pressure unit under this condition. The vessel will be delivered to the Government early in August.

Passenger Motor Boat for South America

J. W. Brooke & Company, Ltd., Lowestoft, recently shipped to South America a 60-foot passenger motor boat built of teak of heavy section, designed to ply between two ports in an open river. Accommodations, divided into first and second class cabins, are provided for 100 passengers. The motive



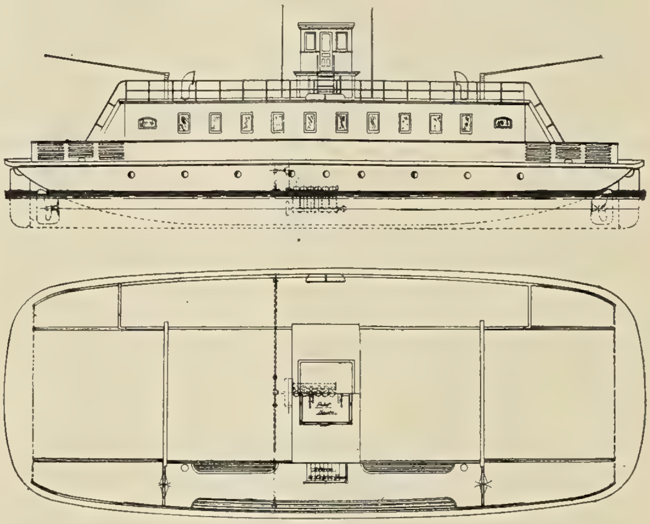
60-FOOT, 11-KNOT PASSENGER MOTOR BOAT

power, which is situated amidships, consists of two 45-horsepower, four-cylinder Brooke motors, with heavy type, single-lever Brooke epicyclic reverse gear, with the two engines driving right and left-hand propellers. The control and steering gear is carried on the upper deck, while right forward of the first class cabin is a forecastle fitted up for the accommodation of the crew. The lighting of the boat is effected by a dynamo driven from the port engine charging accumulators through an automatic switch. On trial the speed of the boat proved to be just over 11 knots.

Motor Ferryboat

A 96-foot ferryboat has recently been built the motive power of which is furnished by a 125-horsepower Standard air-starting and reversing engine. The hull of the vessel is 96 feet long over all, 37 feet 6 inches beam extreme over guards, and 5 feet draft, with accommodations for 100 passengers together with twelve automobiles or the equivalent. The general arrangement of the boat is shown by the illustration.

The adaptability of this form of motive power for a boat of this type is evident from the fact that the engine starts, stops



96-FOOT FERRYBOAT PROPELLED BY 125 HORSEPOWER STANDARD MOTOR

and reverses on compressed air, fed into the cylinders in such a way that it does not interfere in any way with the gas cycle of the engine. The engine is operated from a single point by the shifting of the cam-shaft lever. Owing to the fact that fuel is consumed only during the actual time that the engine is running, this form of motive power brings about a considerable saving in fuel over that required by steam machinery in a ferryboat of this size. The engine is a six-cylinder motor, 8½ inches bore and 11 inches stroke, weighing approximately 5,800 pounds. Engines of this type usually run at a speed of between 350 to 400 revolutions per minute, the actual power developed ranging from 130 to 180 brake horsepower.

Monthly Shipbuilding Returns.—The Bureau of Navigation reports 178 sailing, steam and unrigged vessels of 36,729 gross tons built in the United States and officially numbered during the month of June. Of the total number of vessels built, 7, aggregating 15,968 gross tons, were steel steamships built on the Atlantic coast; 4, aggregating 4,694 gross tons, were steel steamships, built on the Pacific Coast, and 2, aggregating 3,203 gross tons, were steel steamships, built on the Great Lakes. The largest vessel completed during the month was the *Congress,* of 7,985 gross tons, built by the New York Shipbuilding Company, Camden, N. J., for the Pacific Coast Steamship Company. The next largest was the *Richmond,* of 6,563 gross tons, built by the Fore River Shipbuilding Company, Quincy, Mass., for the Standard Oil Company, of California.

New Steamships for the River Plate Trade.—Two new steamers of the Lloyds Royal Holland Line, *Gelria* and *Tubantia,* have lately been launched for the River Plate trade, both of 14,500 tons and a speed of 17 knots. Each will carry 250 first-class, 225 second-class, 140 special third-class, and 900 ordinary third-class passengers. They will sail from Amsterdam for Montevideo on October 1 and December 2, 1913.

Electric Welding

BY CHARLES A. GRAMS, M. E.

Autogenous welding is a system of uniting metals by means of soldering them with a metal of the same composition as the metals to be welded. In marine work at the present day the method of welding is used most extensively on repairs to shafts, boilers, condensers, piston rods, etc., and even broken propellers have been welded, as have also the plates of steel ships.

It is well to have every large ship equipped with a welding outfit. The cost of same is not exorbitant and a special operator is not necessary, as a member of the ship's engine crew can learn to use the apparatus in a short time and become very proficient with it. The time saved by one operation sometimes more than pays for the cost of the apparatus, and the reduced cost of making repairs is another great consideration.

Years ago, in a great many cases, the breaking of the ship's shaft necessitated the hauling of the ship on the ways or in dry dock, where it remained until a new shaft had been made and installed, but in some cases a coupling was made to connect the two broken parts. The method of using a coupling of this character is efficient in some cases, but the method of welding is by far the best.

After a shaft has been welded, as an extra precaution against a break of the weld, a coupling is sometimes also used over the welded part. This should be done only in case of a shaft of great diameter, as a weld on such a shaft may not be done in a thorough manner by some new operators; but there is no great necessity for this.

In the process of welding a broken shaft the ship does not have to be dry-docked, but can be in the process of loading or unloading while the repairs are being made. In several instances certain repairs have been made while a ship was on the seas, but in most cases it is best to weld while there is no vibration of any kind to disturb the separate parts, as in several tests it was found that welds made where there was no vibration whatever showed a slightly greater strength than where just a slight vibration occurred. In most cases, however, no vibration occurs to move the parts, and the weld can be made without any fear of a further break.

Repairs have been made where the operator has had very little work room, where he was cramped and hampered; but as very little room is needed, and as most breaks occur where they can be easily reached, trouble from this source is very little heard of.

There are several methods of welding by use of the electric arc, all of which have their advantages, but the system in most general use and which requires the least skill in operation is known as the Bernardos system. In the Bernardos system an installation of a 75-kilowatt plant, 125 volts and 600 amperes is desirable, but for large and extra heavy work an installation of a 100-kilowatt plant is preferable.

A system of control is essential, as no two welds require the same current strength either in volts or amperes. The water barrel is the most commonly used form of resistance but also the least efficient method, the heating of the water causing a change constantly in the resistance, and consequently in the strength of the current. On this account the water-barrel system is not very satisfactory, and while the gridiron method of resistance is even better the cost of installation is somewhat greater.

In the first method the water barrel is installed in series with the positive pole, and the material to be welded is so adjusted as to consume about 40 percent of the potential strength, 60 percent going to the arc. In most installations there are three barrels connected in multiple, and in case of one weld being on a large section and another on a smaller section, one or more of the barrels can be cut out, and the field rheostat of the dynamo so adjusted as to raise the voltage to the required arc.

The grid in its operation is more even, and when connected with a series of switches, which throw out some of the line resistance as the arc is formed, and throw a certain load on the dynamo when the arc is cut out, will prevent a great and sudden range of load which would cause serious damage to the apparatus. The resistance also prevents the short circuiting of the dynamo by the operator forming the necessary contact or by carelessly allowing the carbon to stay in contact with the welded parts. This has been remedied to a certain extent by installing in the tool a switch which automatically opens the current when released of pressure.

The positive wire is connected to the part to be welded, for the potential reason that a great deal of harm sometimes comes about by the hardness of the weld and the strains set up when the weld cools and shrinks. The hardening is induced by the absorption of carbon from the dioxide of the consumed carbon electrode and the sudden cooling of the heated part. Connecting the positive wire to the part to be welded causes the current to flow from the iron to the carbon and the gases, etc., forced away from the iron instead of to the iron, as would be the case were the flow from the carbon to the iron. It is always best to anneal or cool the welded part slowly to overcome the trouble caused by sudden cooling.

In electrical welding, as in fire welding, it is advisable to use a flux, which acts chemically and absorbs to a certain extent all gases and also prevents slagging in the weld. The flux is applied by sprinkling same over the added metal while the welding is in process.

The Bernardos system, just described, is the most widely known and used system of autogenous welding by the use of the electric arc, but it is by no means the only efficient system in existence. To overcome the defects of the Bernardos system and to eliminate the carbon from the weld, a system making use of a metallic electrode is known as the Slavianoff system.

In this method the same proportional resistance is essential and advisable, but a more even control is desirable. To secure this control only the best alloy wires should be used in the apparatus. The Slavianoff system requires less voltage than the other system. Fifty volts and 165 amperes give the best results on any section to be welded. The current is also divided so as to give 40 percent of the potential strength in the resistance and 60 percent to the arc.

In the Bernardos system the break to be welded is filled with pieces of metal, and these pieces by coming in contact with the negative electrode melt and fill up the cavity, at the same time soldering it. The piece to be welded can only be operated upon from the upper side. On the other hand, in the Slavianoff system the negative wire is attached to the part to be welded and the positive wire terminates in a holder which contains a rod of the same metal that is to be added to the broken piece. By making a contact with the piece and withdrawing it a slight part of an inch an arc is formed, and the end of the rod is fused and the metal from same enters the cavity until the entire rod is consumed and the operation is repeated until the cavity is filled. By this system the metal can be deposited on the metallic surface in most any position, but only steel and wrought iron can be worked on from the under side. As several metals are of a fluid nature when heated they can only be operated upon from the upper side. The size of the rod of welding metal is usually of three-sixteenths or four-sixteenths of an inch in diameter and of any convenient length.

The Slavianoff process is much slower than the Bernardos system, but it is much more reliable and the trouble of the hard welds is entirely dispensed with. Great skill is required to maintain the correct arc, owing to the fact that the welding metal has a tendency to stick to the part to be welded if brought in too close contact, and if held too far away the arc ceases;

therefore it requires considerable time to instruct new operators in maintaining the correct arc.

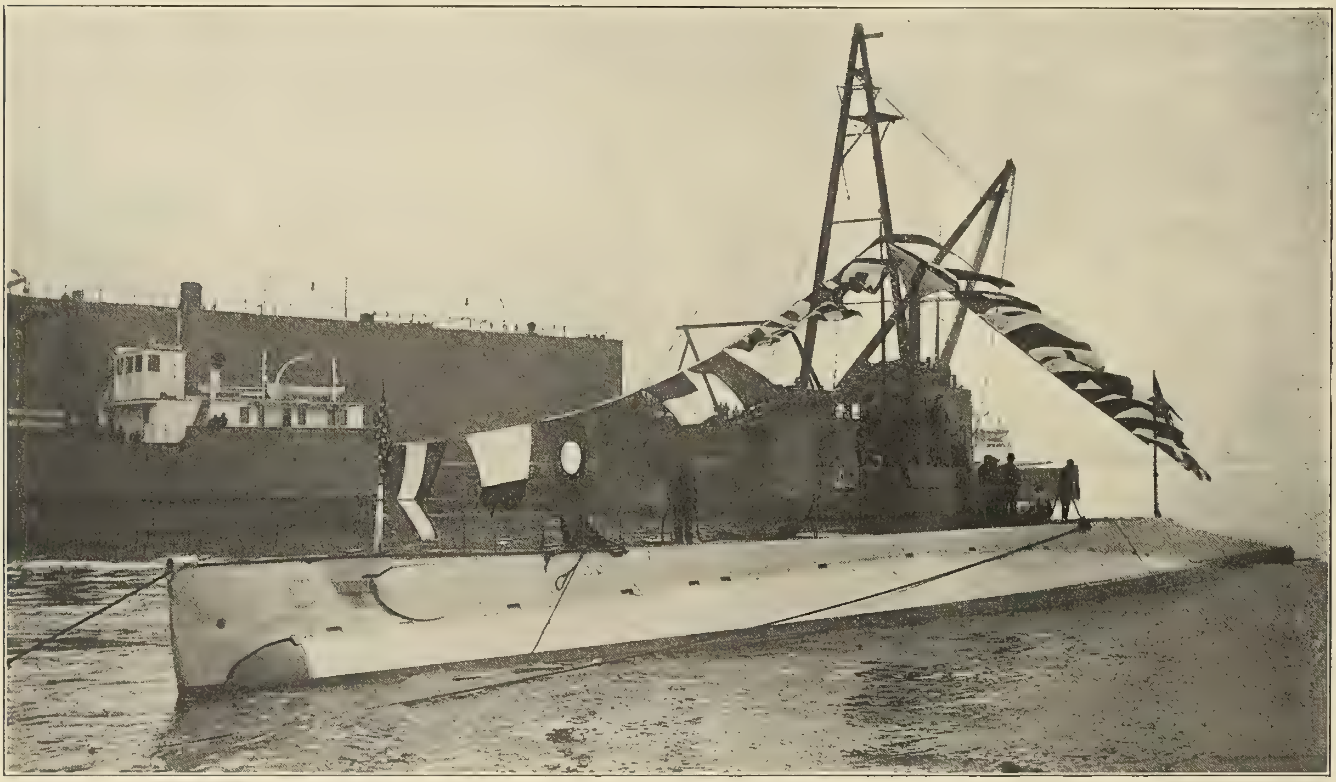
In this process the rate of deposition of the rod of welding metal to the surface operated upon does not exceed 8 cubic inches per hour, and when working on the under side of the surface does not exceed 6 cubic inches per hour. While this process is somewhat slower than the Bernardos process the weld possesses a much more even and smoother finish.

The Slavianoff process is adapted to the repairs of marine boilers in particular, and in Europe, about the Baltic, it is as common as is the oxy-acetylene process in America.

The Zerener process, the invention of a Swiss engineer, is also known as the electric torch process from its similarity to the oxy-acetylene torch. This process is in very little use, extensively on very thin substances, where neither of the other systems is applicable.

In all cases of welding, especially on cast iron, it is always best to heat the parts to be welded somewhat before starting operations, but no general rule of preheating is applicable to all cases, most operators understanding just at what temperature the best weld can be made.

In every series of tests made as to the relative strength of the electric weld and the fire-welded object, it was found that the electrically-welded object was the stronger of the two. As autogenous welding is still in its infancy, we may look forward to the time when it will be in general use, and where the strength of all welds will almost equal the original strength of the piece welded.



LAUNCH OF THE UNITED STATES SUBMARINE H-3 AT SEATTLE, WASH.

owing to the hardness of the finished weld, due to the nature of the flame, which occurs between two carbon electrodes, and is directed downward by a series of magnets set in series with the welding current, although in Switzerland and France it is used to a certain extent.

This system requires a voltage of 85 and 20 amperes, and the output of the welding is extremely small. It is, however, satisfactorily used on light brass objects—zinc, lead and thin iron plates—especially in the trades dealing with stamped steel. the greatest disadvantage being in the extreme hardness of the weld.

In all three systems mentioned there is some drawback, and the use of these systems may be summarized as follows:

The Bernardos system is the best system to use in all work where great strength or fine finish are not desirable, such as the filling of defective castings, etc. The Slavianoff system is the best to use where smoothness of finish and strength are essential, such as the welding of broken shafts, boiler plates and in general marine work. The Zerener system is used most

As the actinic ray is very active in electric welding, and the brightness of the light detrimental to the vision, the operator's body must be protected. The usual method of protecting the head and face is to cover same with a hood with an opening in same for the eyes. This opening is so constructed that pieces of red and green or blue glass may be inserted. It is best to insert a piece of yellow glass between the other two, as this neutralizes the ray of the arc, which is so detrimental to the vision. The hands are covered by leather gloves, while the clothing is sufficient protection for the rest of the body.

Launch of U. S. Submarine H-3.—An event significant in the development of Pacific Coast naval defenses took place on July 3 at the plant of the Seattle Construction & Dry Dock Company, at Seattle, Wash., when the new submarine H-3 was successfully launched. Another submarine, the K-4, is now building at the same plant, and it is expected that its launching will occur early in the fall.

Letters from Practical Marine Engineers

Incidents Relating to the Design, Care and Handling of Marine Engines, Boilers and Auxiliaries; Breakdowns at Sea and Repairs

Repair of a Fractured Feathering Eccentric

The *P*—— *S*—— was taking a pier when the float to which the driving arm was attached struck a log of wood, with the result that a corner of the wooden float was broken off and the eccentric fractured as shown at *A* in sketch. A spare eccentric was not handy at the moment, so the following temporary repair had to be effected: A piece of wrought iron plate 1 inch thick was obtained and cut roughly to the shape of the eccentric and a hole bored in it to go over the "jinny nettle" bracket. The radius rod pins were then dressed down

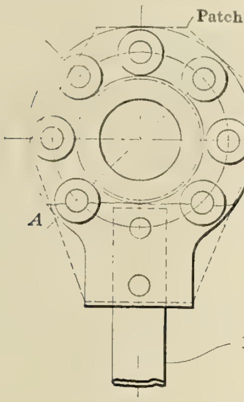


FIG. 1

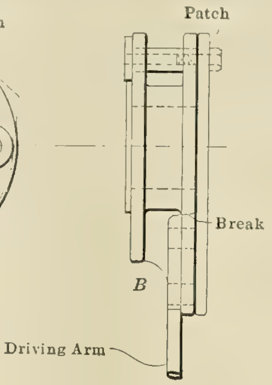


FIG. 2

flush with the eccentric and the holes through their centers tapped to take ⅞-inch pins. The bolts holding the driver in position were removed and longer ones substituted to go through the eccentric, driving arm and plate. The plate was bored to suit these holes and the holes in the radius rod pins, the plate being then bolted and pinned in position, as shown in the sketch. This repair answered admirably until a new eccentric could be obtained, when the old one was removed and the new one substituted. In order to minimize the risk of breakage the new eccentric was made with webs carried on to the other flange, as shown by the dotted lines at *B*.

Glasgow. "Ison."

The Value of Life-Saving Appliances

Some months ago you kindly published a letter from me with reference to this important question. Since then I am glad to say it has made marked progress, and is now receiving that attention from the Board of Trade and the great shipping companies which it deserves. Some three or four factories are now engaged in manufacturing the latest ideas of inventors, which should quickly replace the antiquated lifebuoys, belts and other contrivances which have too often proved ineffective in the past. The Cunard, P. & O., Orient and Atlantic Transport lines have each realized the importance of bringing their outfits up to date, and have given an admirable lead in this direction. It is, however, well known that it is among the small ship owners that the greater apathy prevails, and as this question is so vital a one to many of your readers I am writing this in the hope that they will use every endeavor to make their influence felt. During the summer the provision of modern appliances is a duty laid on the owners of excursion steamers, members of corporations who control sea bathing, riverside risks and so on, for which they owe a great responsibility to the public. The Board of Trade have done their part to some extent by calling attention to the needs of shipping, and, to use an admirable expression from across the Atlantic, it is "up against" other public bodies to do their part.

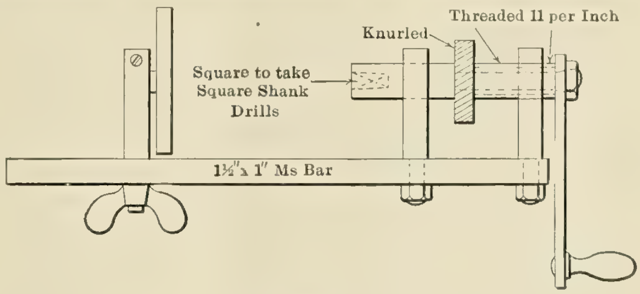
Another and more potent argument will, unfortunately, be supplied by the chronicle of fatalities to be found in nearly every newspaper in this water-loving island during the summer months, many of which might have been averted had an adequate equipment of these recent inventions been at hand, as they cover risks to children as well as adults. Attention is rightly concentrated on the courage which is evinced throughout the country at times of such dangers and rewarded by the medallions of the Royal Humane Society. It would be an equally worthy action if the benevolence of the public showed itself by providing these safeguards at all places not already dealt with by shipping owners or public bodies.

London. John Holland.

Hand Drilling

In any comparison of drilling operations, or any analysis of it as an operation, the outstanding feature is that the pressure required for feed is considerable when considered in relation to the power required to turn the drill.

Some experiments conducted by one firm known to me, using a quite ordinary column drill specially rigged for the occasion, proved the downward pressure needed for a 1-inch twist drill to be approximately 4 tons. This explains the inefficiency of the usual type breast drill, the operator having to



A HOME-MADE HAND DRILL

exert very considerable pressure with his body on quite a small hole.

Drilling with a ratchet, the alternative to the above, is a clumsy operation for small holes. A breast drill is ineffective for holes larger than ¼ inch in cast iron, while to have to rig a gooseneck for a ½-inch hole is a nuisance, especially if the job is small.

Using a ratchet brace, the downward pressure required is minimized by the selection of the shape of drill. From experience of shipyard drillers on piecework, there is more in the shape than meets the eye. Rigging afresh for each 4 holes drilled, 144 ¾-inch holes through M. S. plate ⅝-inch thick in eight hours is a normal output. The price paid was 1 shilling (25 cents) per dozen holes. Each man owns his own ratchet brace, which he brings along to the job. The braces used are of the type carrying a guide sleeve to feed the nut, the screw being totally inclosed from view.

Twist drills are never used. Each man's output would go down 25 percent, it having been tried. Preference is toward a flat smith-made drill having the cutting edge lipped. This is done by placing the edge of the drill on the edge of an anvil while hot, and so giving the edge a cutting rake by means of a blow. Such a drill sinks itself into the metal with the slightest touch of the hand on the feed nut of the ratchet.

On one job 30 drillers were engaged for a month's work. They brought their own smith along, who had to be paid by the yard doing the job, and also a man to fetch and grind drills. Both of these had to be acceptable to the men before they would start.

It shows how discriminating a man becomes when working piecework and using human muscle (his own) for motive power.

Such discrimination is ordinarily a proof of a good workman. A bricklayer purchasing a new trowel and a navvy selecting a shovel are amusing instances of this when witnessed for the first time. Neither would lend his tools for any consideration. The condition of a man's tools is a good index both as to character and efficiency. The first question asked an applicant for employment at several firms known to me is if he possesses a "mike"; this in spite of the fact that in two instances the work done is not of a character making this necessary.

Probably the handiest single tool carried round by a seagoing engineer of my acquaintance is a rather clumsy-looking home-made drill. The sketch shows this tool. The main portion is a piece of 1½-inch by 1-inch bar. It is fitted with two brackets carrying a spindle, which portion may be termed the head stock, and a similar loose bracket which might be called a tail stock. The 1½-inch by 1-inch bar has ½-inch holes pitched 1 inch apart and the tail stock slips into these.

In use the bar is gripped in the vice, and the jobs possible to such a primitive-looking contrivance are many. It will drill ⅝-inch holes from the solid and will open same out to 1 inch without difficulty. Personally I have bored out winch brasses by its aid, doing some juggling to set same up fair.

The contrivance takes care of end pressure which a breast drill cannot do. With two centers, some primitive turning has been successfully accomplished by its means, using the vice jaw as a rest and gripping the device at the lowermost point of vice jaws. Naturally it has limitations which are obvious, but before criticism is passed it is necessary to give it a trial.

Its capabilities are many, and I think its owner would sooner part from his beard, of which he is inordinately proud, rather than lose his home-made contrivance. It was made at sea, the brackets filed up from the solid, the spindles were made from annealed round files, the bar was dressed up with a file and the holes drilled with a ratchet brace. It probably cost its weight in gold in labor.

I hope the device as illustrated will stimulate some small tool firm to turn out something similar in design. The bar could be round, a lug being left on the two brackets forming a head stock to take the grip of the vice, while the portion acting as a drill table can then swivel to any desired position and could be made to lock in any ordinary manner.

In use it is, of course, necessary to abandon the superstition that drilling must necessarily be done in a vertical position. A short experience of its capabilities will certainly find it some steadfast friends.

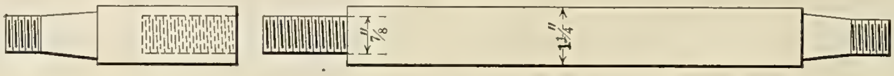
London. A. L. Haas.

How a Broken Feed Pump Rod Was Repaired

The writer, while first assistant engineer of a ship running between New York and Mexican ports, repaired a broken feed pump rod in the manner shown by the accompanying illustration.

This ship had six boilers and two duplex feed pumps. One was large enough to supply all six boilers while the engines were running full speed; the other was only of sufficient capacity to supply four boilers, and was used while running between Mexican ports when the ship was under reduced speed.

The first day out of New York one of the rods in the main feed pump broke at about one-third of its length from the end—a part that passed through the stuffing box. It seemed almost compulsory that this pump be repaired, for the reason that it was the only pump that could be used to feed the boilers and keep the engines at full speed. The donkey pump was large enough and was connected to the feed line, but it was located on the middle grating, which necessitated lifting the water about ten feet. Part of the auxiliary exhaust steam was led into the filter box to heat the feed water, and with the feed water at a temperature of 180 degrees Fahrenheit this pump would not lift it that distance, and unless it was so heated the steam pressure could not be maintained. The other feed pump, of course, could not be used unless the engines were slowed.



METHOD OF JOINING A BROKEN PUMP ROD

Fortunately, the break was almost square across, and it was proposed that a stud be inserted in one end and the other end be drilled and tapped and thus fasten the two parts together.

The chief was some doubtful about being able to do this successfully, but, as the pump was useless, agreed to the proposition. The broken ends were first filed perfectly square across and then a hole for a ⅞-inch tap was drilled fairly in the center of each broken end of the rod, which was 1¼ inches in diameter. It required neat work to get the holes in the exact center, they having to be drilled by hand with a ratchet, and of course had to be perfectly parallel with the center line of the rod. When these holes were drilled and tapped in each part of the rod a thread was cut on a piece of ⅞-inch steel, so that it would screw into the holes neatly but not so tightly that it would swell the rod, which was made of Muntz metal. The stud was inserted in one end of the rod and sawed off the proper length, the rod then being in the shape shown in the sketch.

When the two parts were screwed together the ends came together so fairly that the joint just showed like a fine crack. The repaired rod was then put in place in the pump and performed its duty perfectly until arrival in Havana.

A new rod was ordered by telegraph to meet the ship in Havana on the return voyage, and the smaller feed pump used between Havana and Mexican ports, two of the boilers being cut out on this part of the voyage. The repaired rod was afterwards carried as a spare one. J. S.

Mending a Crank Shaft in Queer Surroundings

While many of our seafaring men see many queer things during their travels in foreign lands, yet our different experiences are interesting to each other, just for the novelty that many strange sights bring into our remembrance, for we all see a different side and can tell it in a different way. The little breakdown that was the cause of this narrative would have long ago been forgotten had the surroundings with its repairs not been so novel and humorous.

It was in 1895 and the first time that I had been in China. We were up the Ming River, at Pagado Anchorage, near Foochow, when the three-inch shaft in our circulating pump broke, between the engine and the centrifugal pump, and not having a spare one, nor the facilities for welding it, arrangements were made to take it to a Chinese blacksmith shop three miles from the ship. The writer, with two men to handle the shaft, was put in a boat and landed at the point where we were told to be at six o'clock the next morning, where transportation would be waiting for us.

On our arrival we saw a man there with a wheelbarrow, who seemed very anxious to get the shaft on the barrow, but this was not what I had expected, and so, after waiting for half an hour for some one to come for us, the Chinaman with the barrow went away and shortly returned with a man that could speak a few words of English, and we were made to understand that the wheelbarrow was the means that had been provided for our transportation.

We put the shaft on, and after fifteen minutes more of expostulations, understood that we were to get on the barrow also, which we did, with the shaft and the lightest man on one side, and the two remaining on the other. We started for the blacksmith shop much faster than I had expected.

After traveling about a mile we came to a turn in the path which brought the wind nearly abaft, and which was blowing quite strongly. Here the man halted, as I thought, for a rest, but I soon had my mind changed, for from under the barrow he hauled out a long pole and set it up on the barrow with guys, just as a small mast would have been rigged in a boat. I thought that he was rigging some kind of a sun shade for us, for the sun was quite warm, but he produced another pole attached to a piece of canvas made fast to the halyard, and up went a sail ten feet high and six feet wide, which he trimmed so that it hauled well, and to my amazement off we went on a wheelbarrow, under sail, and with considerably more speed than we had been making. Before we had reached the blacksmith shop I had a great deal more respect for the barrow man that before we had started.

But once at the shop I soon forgot the barrow man, and almost the rest of the world, for a while, for of all the things that that blacksmith shop contained, and the things that the blacksmith did, kept me so busy that I had time for nothing else. It was very little trouble to show them what I wanted done, for they could see that the shaft was in two pieces and had been broken, and by instinct, I guess, they knew that it ought to be one piece instead of two. However, I must say to their credit that they made a splendid job of it, although I made four more trips on the wheel barrow before I found it finished.

The first thing that I noticed on my arrival, after making sure that they understood the distances, etc., which I made clear with center punch marks and trams, was the way that they shoe horses, which they were doing at the time. A horse to be shod is taken out in the yard, where four strong posts stand firmly set in the ground with a windlass attached to two; a large piece of leather suspended from the other two posts completes the equipment by which the horse is drawn up until clear of the ground, similar to the way oxen are triced up when shod. The foot that is to have the shoe nailed on is fastened in a clamp for that purpose, so that the horse can't move it. Then the shoe, consisting of a very narrow strip of iron, is fastened with hand wrought nails which the blacksmith makes at odd times. All four shoes would not make one of the shoes used on an American horse. It costs about 8 cents (4d.) to put all four shoes on, and less if old ones are refitted.

The forge is roughly made, but similar to any forge except for the attachments that go with it. The fire has a covering of sheet iron, with an opening through which to thrust the iron that is to be heated. In the top of the casing is fitted a large copper kettle, and families send their rice to the blacksmith to be boiled in this kettle for a share of the rice or one quarter of a cent (⅛d.) per pound. When finished it is put aside until the owner calls for it. As it takes the rice from several families to fill the kettle, which is large enough to hold eighteen or twenty pounds at a boiling, it sometimes causes trouble for the blacksmith to give each patron his exact share. He must judge the quantity brought to him by each one, and when it is cooked divide the rice in the same proportion, after setting aside his share. He seemed to have less trouble boiling the rice than he did delivering it, for several of the women were dissatified with his division, but often the very smallest amount, even a teaspoonful, seemed to satisfy them. As near as I could understand the system it was cheaper to have the blacksmith boil the rice than it was to buy fuel and boil it themselves.

This is not all that the blacksmith gets from his fire, however. Along the side of the shop was a brick platform, wide enough for a man to lie out straight on, and long enough so that ten or twelve men lying side by side could be accommodated to sleep or rest. The hot gases passing under the platform from the forge keep the sleepers warm, and this the blacksmith charges for by a regular schedule, according to the length of time that the person wishes to sleep. This warm bed is only used in the winter time.

The bill for the shaft, by the way, was $1.45 (6s. ½d.) and for the barrow man 35 cents (1s. 5½d.) Reader.

Towboat Propeller Wheels

The writer, in the course of his professional work, has at various times noticed that the average towboat engines turn up at revolutions that are in excess of what they should turn for the work they were doing. Having been called upon to improve conditions on several ocean-going as well as harbor tugs, the opportunity was secured to study conditions as they obtain in nearly every case.

The towboat suffers from the fact that it is fitted with the traditional towboat wheel, having excessive area, wide tips and very thick blade sections. Just why a towboat should have a different form of blade from any other type of screw-propelled vessel is beyond my comprehension, and I can say without fear of successful contradiction that there does not exist any reason.

Some of the towboats I have investigated had wheels with radial increasing pitch, some had both radial and axial increasing pitch, while others had axial increasing pitch only. Each maker has had his own idea about expanding pitches, but all seem to have agreed to maintain the wide tip and excessive area, while the thickness of blade, if ever computed, had an allowance of plus 100 percent to cover errors, etc. Let us examine the wide tip, or, better, the traditional type of blade.

From careful examination of numerous wheels of this type we find that there is excessive friction at the tip, and in many cases which the writer has examined the blades were smooth from 12 to 18 inches from the tip, while the remainder of the blade was the same as the day it was put on. That is to say, in many cases the paint was intact, and those which were not painted were the same as received from the foundry. The question may be asked, why is this not due to unequal pitch, etc., or due to casting? It did not happen in one case only, but was manifest in nearly all, and the line of demarcation was very clearly defined.

Now the harbor towboat works under the following conditions at different times: Running free, towing and berthing ships by either pulling or pushing.

A towboat should not be sluggish. As they have large power to enable them to tow, they are as a rule lively. Towing should be done at maximum efficiency. When berthing ships a towboat should recover very quickly. The ordinary towboat wheel is a notoriously poor backing wheel, and unless the man in the pilot house thoroughly understands his wheel there is often a damage suit involving thousands of dollars.

In 1907 and 1908 the writer, in designing several towboat wheels for ocean-going and harbor tubs, decided to depart from all conventional forms of blades, and therefore designed an oval blade having well-rounded tips, and the blade sections such that the factor of safety was 5.5 for cast steel. These propeller wheels were four-bladed, and ranged from 5 feet 6 inches to 8 feet diameter. The projected area ratio was 0.52; the pitch ratio varied from 1.1 to 1.58. The results obtained surpassed expectation, and were as follows:

With the new wheels the revolutions of the engines were decreased; in one instance from 125 to 118, with a much higher efficiency when towing, resulting in a reduced fuel consumption. The boats handled larger tows at a higher speed. The backing qualities were far superior, and when docking handled more readily, thus saving considerable time. One boat which towed car floats, and had to tow from terminal to terminal in a given time, was enabled to handle heavier floats, and reduced her running time twelve minutes on a test against a heavy northeast wind and strong tide. With the old wheel the cut-off was 8 inches, while with the new wheel she could do better work on a 6-inch cut-off.

With the wheels designed for the ocean-going tug the pitch ratio was 1.1, with a projected area ratio of 0.513, and the blade was the same shape as mentioned for the previous tug; in fact, this shape has been used as the parent lines, and I have used it for freight and passenger steamers as well. The pitch in all cases was uniform. It must be borne in mind that a towboat when towing has a very high slip, and combined with this high slip the efficiency with the traditional type wheel is very low, but with the new wheels the efficiency was between 60 and 65 percent, the lower figure for the harbor boat.

Let us return to the cause of the high revolutions. Froude found in recent experiments that wide-tipped blades were about 3 percent less efficient than well-rounded blades. I have found that the wide-tipped blades are in actual practice much greater than 3 percent less efficient, but when compared to an oval blade with well-rounded tip the difference is much greater. I shall in the near future determine this with accuracy from an actual test of a large ocean tug. It is well known that thick blades set up a negative thrust, and this detracts from the positive thrust, enabling the engines to run faster. This condition exists with all the traditional tow-boat wheels.

Any one who has been shipmate with a cast iron or cast steel wheel (the cast steel wheel being cast from the same pattern as the cast iron wheel), which has been replaced by a bronze wheel having the same diameter and pitch as the others, but whose blades are much thinner, has noticed that the bronze wheel has reduced the revolutions of the engines. I have had them reduced ten turns per minute, yet the speed has been higher. The reason for this is simply due to the fact that, the bronze blade being thinner eliminates a great amount of the negative thrust, delivering a greater positive thrust, resulting in reduced revolutions with increased efficiency.

My investigations have led me to believe, and results have amply proved, that the oval blade with well-rounded tips is a far more efficient towing wheel than the wide tip. The blade should not be too wide. The area should not be excessive, a projected area ratio of from 0.5 to 0.55 is desirable, as with increase of area ratio a loss of efficiency will obtain, which has been proved in several cases. With reduced revolutions more work is obtained and higher efficiency, resulting in a saving of fuel, which in one case amounted to 7 tons per month. The boats handled more quickly and recovered in much less time and corresponding distance. The vibrations in three cases, which were with the old wheel very great, entirely disappeared, yet the wheel received no greater care in this detail than the old wheel, and the solution is apparent.

Curves for four boats were plotted as follows:

Abscissæ	Ordinates
Speed in knots................	Horsepower.
Speed in knots................	Indicated thrust.
Revolutions per minute........	Speed in knots.
Revolutions per minute........	Indicated horsepower.

All four series of curves show the same characteristics. The friction of engine shafting, etc., was computed at 8 percent, making mechanical efficiency 92 percent, as the engines were well worked down and in good condition. In every case the wheel had no fall back, as there was ample distance from stern post to blade, so that the wheel was not working near dead water, the stern post being thin and the boats having a fine run. Where a stern post is very thick, as on some wooden ships, it may be and is advantageous to give the wheel a fall back for the reasons above, but when this can be avoided it should be, as there is no gain by so doing.

This recalls an incident where a thick stern post was the cause of negative slip appearing on the log until we got tired of figuring that, after the ship tied up, the engines would have to run for a long time to change the negative sign to a plus one. The steamship *E*———, engaged in coastwise trade, being built of wood, had a very thick stern post, which spelled dead water some distance aft of same. The chief engineer decided to fit triangular pieces to it to reduce this dead water. The propeller wheel had no fall back, which in this case was a great error. After these pieces were fitted the slip did change signs, and instead of having negative slip we had an 8 percent, apparent. One night going over Charleston bar this piece was ripped off, although we did not know it at the time we hit, and on the return run we had the negative condition, and when we tied up at the home port an examination revealed the fact that our pieces were not there, but they were at once replaced.

Now a great mistake is made when we do not design the wheel to suit she lines of the hull. With our present-day methods there is no reason to use rough-and-ready methods of design. If it be a towboat, freight steamer or a fast passenger steamer, we can determine the proper power by having our model towed in the tank, and from this information design our wheels to suit our hull and power. A towboat should be an efficient machine when towing, for they seldom run light, and maximum efficiency should be obtained in any case when the ship is performing that service for which she was designed. The question of fuel to-day is a most important one, and every refinement which can be introduced to save it should be adopted.

The average towboat wheel is gotten out in the following manner: An order is received for a wheel of such and such diameter and pitch. At once there is a perusing of the list to see if there is a pattern of one on hand. In case there is not, then the nearest pattern is selected and pieces put on to bring the diameter up to that required; but more than once I have heard the remark. "They won't know the pitch, so let it go"; and go it does. In one place where they do a large wheel business the particulars of a wheel are absolutely unknown; the area is great, the tip wide, and the wheel is of the traditional towboat type. Charles S. Linch.

New York.

French Line's Activities.—At the annual meeting of the Compagnie Genérale Transatlantique at Paris on June 23, it was shown that receipts in 1912 were $18,294,000 (£3,750,000), an increase of $1,293,609 (£265,500) over 1911. The dividend declared was $401,440 (£68,300), while the company's assets are $38,000,000 (£7,800,000).

Marine Articles in the Engineering Press

The Canadian Lake and Canal Steamer Glenmavis.—The *Glenmavis* is the first vessel to be completed by the newly-constituted North of Ireland Shipbuilding Company, at Londonderry, and belongs to what is known as the canal type of lake freighter, in which the dimensions and the draft are limited by the size of the canal locks through which such vessels ply. The vessel differs from other lake vessels in that she is the first of this type to be constructed on the arch principle devised by Mr. Maxwell Ballard. The hull is 250 feet long between perpendiculars, 42 feet 6 inches extreme breadth, 20 feet total depth, 14 feet load draft. There are six large cargo hatches, and, although it is unusual to install cargo gear on board such vessels, it is understood that the owners contemplate adding four winches, with the corresponding cargo gear, masts and derricks when the vessel reaches the Lakes. Propulsion is by a single screw, driven by a triple-expansion reciprocating engine, with cylinders 16, 26 and 44 inches diameter by 30 inches stroke. Steam is supplied at 180 pounds pressure by two single-ended cylindrical boilers, working under natural draft. The propelling machinery was constructed by Messrs. Richardsons, Westgarth & Company, Ltd., of Middlesbrough. 6 illustrations. 850 words.—*The Shipbuilder,* July.

Shipbuilding at Londonderry.—A new shipyard, the North of Ireland Shipbuilding Company, Ltd., has been installed at Londonderry, a place where shipbuilding has been carried on to a small extent in times gone by, but which during dull times was forced to give up activities in this direction. On the site of the new shipyard there was formerly a well-equipped shipbuilding plant where principally sailing vessels were built. The old yard, however, has been idle for twelve years, and whatever buildings or machinery was left from the old yard were of little use in the new establishment. Practically everything in the shape of buildings, machinery, etc., had to be renewed for the new yard, and, in spite of the fact that so much work was necessary, the firm placed the shipyard in working condition and built and delivered a 250-foot vessel of special type and unusual form within a brief period of six months for actual building, the launch taking place in less than ten months from the date when the company took possession of the site. There are four building berths in the yard, the longest being capable of taking a ship up to 470 feet in length. Electric power is used throughout the entire plant and electric winches are installed alongside the berths. Immediately above the building yard is a drydock, and on the quay adjoining, all forming a part of the shipyard premises, is a large steam crane of 60 tons capacity for fitting out vessels. 12 illustrations. 1,500 words.—*The Shipbuilder,* July.

The Isle of Man Geared-Turbine Steamer King Orry.—The geared-turbine steamer *King Orry* was designed and built for the Isle of Man Steam Packet Company at the Birkenhead works of Messrs. Cammell, Laird & Company, Ltd. This is the first geared-turbine steamer trading in the Irish Sea. After a brief historical review of the work turned out at the Birkenhead works, a detailed description is given of both the hull and machinery of the new vessel. She is 300 feet long, 43 feet beam, 12 feet 6 inches draft, 2,550 tons displacement, 1,850 tons gross, driven by twin-screw geared turbines, indicating 8,000 horsepower, using steam at 170 pounds pressure, developing on trial a speed of 20.75 knots. The hull is subdivided by nine watertight bulkheads extending to the upper deck. Accommodations are provided for 1,600 passengers and a crew of seventy-five. The propelling machinery includes two high-pressure and two low-pressure turbines of the latest Parsons compound impulse and reaction type. The two high-pressure turbines are in the center, and the two low-pressure turbines, with which the astern turbines are incorporated, are in the wings. The conditions of service demand ample backing power, and therefore the astern turbines are designed to develop 60 percent of the maximum ahead power. Steam is supplied by three Scotch boilers, two double-ended and one single-ended, with a total collective heating surface of 14,385 square feet and a total grate area of 383 square feet. 19 illustrations. 2,250 words.—*Engineering,* June 27.

The New French Battleships.—Some novel features of more than usual interest will be found in the four French battleships that are to be laid down this year. They are to be 574 feet long, 89 feet beam, 25,000 tons displacement on a draft of 28 feet 3 inches. The main armament will consist of twelve 13.4-inch guns, carried in three quadruple turrets placed on the center line. The secondary armament consists of twenty-four 5.5-inch guns. The designed speed is 21 knots with about 32,000 horsepower, which will be developed on four shafts, the two outer shafts being driven by reciprocating engines and the inner shafts by turbines which are self-contained and entirely independent of the reciprocating engines. The main armor belt will be 12½ inches thick, and above that the armor will be reduced to 8 inches. The most striking features of this design are, of course, the use of quadruple turrets, which are severely criticised; the installation of two different types of main engines independent of each other, in spite of the proved economy of the combination of the two; the adoption of a special type of Belleville watertube boiler, specially arranged to admit forcing at high rates of combustion, and the location of the secondary battery, which does not seem to be advantageously arranged. Other novel features referred to are the use of two rudders in place of one, which is an innovation in French warships, the installation of anti-rolling tanks, and the installation of special pumping apparatus provided for use in the event of submarine damage. 2,300 words.—*The Engineer,* July 4.

The New Gladstone Dock at Liverpool.—A few paragraphs at the beginning of this article outline, briefly, the remarkable increase in volume of traffic and the steady growth in the size of individual ships which have demanded great improvements in the facilities and accommodations of the port of Liverpool. The main question discussed in the article is that of dock expansion and reconstruction. A very comprehensive outline of the work done in this respect during the last quarter of the nineteenth century is given, showing the necessity for the provision of a graving dock of the size of the new Gladstone dock, which is 1,020 feet long, 120 feet wide at the entrance, with a depth of water over the sill of 46 feet at high water of ordinary spring tides. The Gladstone dock forms the first part of an extensive scheme involving the expenditure of over three million sterling, authorized by the act of 1906. The scheme embraces dock works extending northwards on the Seaforth shore from the extreme northern end of the existing docks for approximately 2,600 feet and seawards into the River Mersey for about 2,200 feet. The works proposed include besides the Gladstone dock an entrance lock from the river, which finally will undoubtedly exceed the dimensions originally proposed of 870 feet length and 130 feet width. In the dock area there is to be a half-tide dock of 14¾ acres, and from this area there will stretch landwards two branch docks each 400 feet wide and separated by a quay over 1,300 feet long. There will be double story sheds 100 feet wide adjacent to each wharf face. The main part of the article is concerned, of course, with details of the design, construction and operation of the Gladstone dock. An interesting feature of the pumping plant is the fact that the pumps will be driven by oil engines of the two-cycle Diesel-Carels type. The complete pumping installation is carried out by the Worthington Pump Company, Ltd. The duty required is to empty the dock of its full contents, about 44,000,000 gallons, or 200,000 tons, on an 18-foot tide, in two and one-half hours. There are five sets of centrifugal pumps with discharge pipes 54 inches in diameter, each having a valve operated by a hydraulic cylinder working under 700 pounds pressure. Each pump is driven direct at 180 revolutions per minute by a four-cylinder engine of 1,000 brake horsepower. 18 illustrations. 5,500 words.—*Engineering*, July 4.

The Cruising Element in Warship Machinery.—Two destroyers are being built by Messrs. Yarrow which are similar to three very successful vessels built by the same company for the British navy, which have a length of 255 feet and a displacement of 765 tons, and with which a speed of over 35 knots was realized. On the two destroyers now building oil engines are being installed for cruising, and it is estimated that this arrangement will give a radius of action of 700 sea miles at full speed and of 8,000 sea miles at half speed. The disadvantages of the arrangement, however, appear to be the reduction of the maximum speed obtainable to the extent of about one and one-half miles per hour, the addition of about 100 tons to the weight of the machinery, and an increase in the space occupied by the machinery of about 15 percent. Another serious objection to this arrangement is the fact that when cruising with the oil engines the power for high speed at short notice which should be available in a warship could not be obtained without keeping up steam in the boilers and keeping the turbines heated. On the other hand, in a typical present-day destroyer fitted with the normal type of turbine machinery without a cruising turbine the vessel might carry 200 tons of oil fuel, which, at a given cruising speed, would enable her to have a radius of action equal to 2,000 nautical miles. The maximum speed with the tanks full would be 32 knots, but, as the fuel was gradually consumed, the speed would run up to 35 knots, at which speed the vessel could steam for twenty hours. By adding an internal-combustion engine to achieve economy at cruising speed the radius of action at cruising speed would be increased to 8,000 nautical miles, but on account of the increased weight of the machinery the maximum speed would be reduced 1½ knots. In this case the time during which full speed could be maintained would still be twenty hours. A third case would involve the installation of cruising turbines in addition to the main propelling turbines. The weight would be considerably less than in the case of the fuel oil engine, and for the same displacement more fuel could be carried; thus the radius of action would be a little more than half that of the destroyer with internal-combustion engines for cruising, or about 4,500 nautical miles. The speed with the tanks full would be the same, but with the tanks ampty would be higher, and full speed could be maintained for twenty-eight hours instead of twenty. If superheating to the extent of 100 degrees were adopted for the cruising turbines, the radius of action might be increased to 5,000 nautical miles. The conclusion is reached that on the whole the advantages were distinctly in favor of adopting the cruising turbine and of using superheated steam. Because, although there is some loss in the radius of action at cruising speed, there is a gain in the rate of speed during a prolonged full speed run as well as the possibility of covering nearly 50 percent more ground at full speed. 1,600 words.—*Engineering*, June 20.

Steam Turbines.—By Lieut. B. A. Straight. This article is a continuation of a paper which appeared in the preceding volume of the United States Naval Institute Proceedings. It is entirely descriptive, and takes up the Curtis, Parsons and Terry turbines, illustrating the description by drawings of turbines actually installed in certain United States war vessels. A chart is given showing the performance obtained with different methods of turbine drive, including direct Parsons and Curtis installations and geared turbines and turbo-electric drive. 5 illustrations. 2,300 words.—*United States Naval Institute Proceedings*, June.

The Desirability of Using High Mean Referred Pressures.—By E. M. Bragg. In the past it has been considered that an economical engine must have a large number of expansions. The author considers that too much importance has been assigned to the question of the number of expansions. Experimental results have shown that more attention should be given to the mean referred pressure employed, and to the cut-offs in the intermediate and low-pressure cylinders if economy of steam is desired. The author refers to statements made by Mr. R. Royds in a paper read before the Institute of Engineers and Shipbuilders, and a paper by Professor Weighton upon "Receiver Drop in Multiple Expansion Engines," read before the North-East Coast Institute of Engineers and Shipbuilders, which tend to bear out his statement. The results obtained from the trials of the U. S. S. *Delaware, Birmingham,* and upon H. M. S. *Argonaut,* agree in general with the conclusions reached by Mr. Royds and Professor Weighton, to the effect that higher mean referred pressures are necessary for economy. In every case the use of lower mean referred pressures is accompanied by increased steam consumption. In considering the effect upon the steam consumption of the percentage of cut-off used in the low-pressure cylinder, it is shown that an appreciable reduction in steam consumption can be obtained with an earlier cut-off in the low-pressure cylinder. 2 illustrations. 2,400 words.—*Journal of the American Society of Naval Engineers*, February.

The Lillie Quadruple Evaporator U. S. S. Dixie.—The Lillie quadruple-effect sea water distilling plant, designed and patented by S. Morris Lillie, of Philadelphia, Pa., and installed on the U. S. S. *Dixie* by the Sugar Apparatus Manufacturing Company, of Philadelphia, is peculiar to such a degree in its mode of operation and in other respects as to make it radically different from anything that has been used heretofore for the purpose in the navy. There are two very salient differences: First, the evaporation from the sea water is from films caused by a mechanical showering of the sea water over the evaporating tubes, and, second, the movement of the evaporators or heat through the apparatus is periodically reversed. The former greatly promotes the efficiency of the evaporating surface, and the latter by a frequent changing of the temperatures through the effects prevents incrustations to such a degree that the apparatus may be run for long periods without a material falling off in capacity. The rated capacity of the quadruple effect is 25,000 gallons of distilled water per twenty-four hours. The space occupied by the apparatus is about one-half of that occupied by the navy type of the same rated capacity, and the weight is about 30 percent less. The apparatus is thoroughly described with the aid of numerous diagrams, and the results from a 72-hour capacity test are given. A careful account was kept of the actual consumption each day, from which it was estimated that nearly 74 pounds of fresh water were made per pound of coal used, a remarkable result, which is due to the use of exhaust steam as the heating agent. The plant is more complicated and requires more careful attention than the navy type, the liability to breakdown is slightly greater and it is more difficult to repair, but this should be considered with the fact that it has more functions than the navy type. 5 illustrations. 5,500 words.—*Journal of the American Society of Naval Engineers*, February.

New Grace Liner.—The steamship *Santa Catalina*, building at Cramp's shipyard for W. R. Grace & Company, of New York, was launched July 19. Her dimensions are: Length, 420 feet; beam, 54 feet; capacity, 10,000 tons. She will be used in the Panama Canal trade.

New Books for the Marine Engineer's Library

Works Management

THE PROTECTION OF TRADE DESIGNS By Robert M. Neilson. Size, 4¾ by 7¼ inches. Pages, 29. Glasgow, Scotland: Fraser, Asher & Company. Price, 6d. net.

The purpose of this volume is to supply information as to the registration of design and the protection afforded thereby. Also to indicate as far as possible what is and what is not suitable subject matter for registration, and generally to give advice on the subject of a nature to be readily understood and appreciated by manufacturers, merchants, agents and the like. The frequent neglect of many manufacturing firms to take the precaution of registering trade designs results in needless losses. As this is apparently due to ignorance on the part of the manufacturers as to the advantages which can be gained by registration, it would be worth while for every manufacturer to obtain a copy of this pamphlet, especially those manufacturers who do business in Great Britain, the country to which the contents of this pamphlet applies.

COST REPORTS FOR EXECUTIVES. By Benjamin A. Franklin. Size, 5½ by 8½ inches. Pages, 149. Ten charts. New York, 1913: The Engineering Magazine Company. Price, $5.00.

As stated in the preface, the object of this book is to discuss with the executive of a manufacturing plant, after a considerable experience, not how to build a cost system, but what he should have when his cost system is built; to illustrate it by actual forms, filled with figures to make their use clear and to discuss with him the values, the uses and the essential necessities of a right and practical cost system, with the idea in mind constantly of showing him, through casting it into the forms shown, the vital operations of his material, labor and expense. Their relations, one to the other, are made plain, and the whole manufacturing situation so illustrated as to offer him a grip upon it. The discussion in the book, therefore, is not limited in application to any particular business, but illustrates principles that can be carried out in various ways to suit varying conditions. A great deal has been written upon the subject of costs, but this book takes up the matter from a somewhat unusual point of view, although a most valuable point of view, and one that should make the subject of particular interest and value to manufacturers in any field of business.

MODERN ORGANIZATION. By Charles Delano Hine. Size, 5 by 7¼ inches. Pages, 110. New York, 1912: The Engineering Magazine Company. Price, $2.00.

This book forms an additional volume to the "Works Management Library," published by the Engineering Magazine Company, and is made up of a series of articles which appeared originally in *The Engineering Magazine* early in 1912. Major Hine's "Unit System," which has met with remarkable success on the Harriman Lines in promoting efficiency without causing trouble, is based on the fundamental ideas of correcting over-centralization and over-specialization by simple changes of official relation and departmental routine. The book explains exactly what this system is and how it was put into effect on the Harriman Lines. A striking feature of the system, and one which will appeal to works managers, is the fact that no elaborate system is introduced. There is no cumbersome mechanism, no changes are made affecting the rank and file, the system works by changing the relations and the viewpoint of the directing official, thus operating first upon and then through him. While the ideas and methods have been applied most widely to railway operation, they may be adapted to any situation, whether Government bureau, commercial company or manufacturing and industrial corporation, as the policies are largely mental suggestion, which creates and transforms the ideals which are the first principle of efficiency. The scope of the volume is indicated roughly by the chapter headings, which are as follows: The Unit System on the Harriman Lines; Operation of the Unit System; Broadening the Ideals of Line Supervision; Over-Specialization; Fallacies of Accounting; Supplies and Purchases; Line and Staff; Genesis and Revelation of Organization.

American Yachts

LLOYD'S REGISTER OF AMERICAN YACHTS, 1913. Size, 9 by 7 inches. Pages, 506. Illustrations, 46 full-size plates. New York, 1913: Lloyd's Register of Shipping, 17 Battery Place. Price, blue cloth, $8.50; plain canvas, $7.

Coincident with the opening of the yachting season, the eleventh annual edition of Lloyd's Register of American Yachts is now ready and has been shipped to subscribers. The book contains the particulars of 3,557 power and sailing yachts distributed in all parts of the United States and Canada, and also Mexico and the West Indies, located as far north as Nova Scotia and British Columbia, and as far south as Mexico, Bermuda and Cuba. The yacht clubs of this same territory, to the number of 526, with 36 yachting associations, are also included, with the full list of officers for the current year. The yacht owners number 3,550, the address of each being given.

The new yachts of the year, to the number of a little over 300, are made up mainly of cruising launches of 30 to 50 feet length, the majority of the raised-deck and trunk cabin type. There are also a number of cruising yachts of about 100 feet, driven by gasoline (petrol) engines, representing the latest progress in this most useful type. The steam division has been increased by several large cruising yachts and a few of medium size.

The most interesting development of the year in building is the new one-design class of 50-footers, wooden yachts, 72 feet over all, 50 feet load waterline, 14 feet 6 inches breadth, and 9 feet 9 inches draft, rigged as knockabout sloops, no bowsprit, single headsail, and pole mast carrying a large club topsail. This class of eight yachts promises a revival of yacht sailing about New York and Newport, and should do much to awaken a wider interest in racing. Another interesting class includes five one-design schooners of 40 feet load waterline, fostered by the Stamford Yacht Club, that will be seen in all races on Long Island Sound. A still smaller class of four one-design auxiliary yawls of 32 feet load waterline has been built for the south side of Long Island.

The largest of the sailing yachts is the new *Vagrant* built for Mr. Harold Vanderbilt, a composite schooner of 78 feet load waterline, to be raced abroad; while Mr. Max Agassiz has replaced the old *Kirin* by a steel auxiliary schooner, with an engine of the Diesel type, 82 feet load waterline, for cruising. A goodly number of sailing yachts has been added in the smaller classes, and the season promises to be a specially lively one as far as sailing and power races are concerned.

This year's Register contains a total of 506 pages, including The American Yachting Trade Directory, which has become a very valuable feature; the 46 color plates show the burgees of 548 yacht clubs and associations and the private signals of 1,822 yacht owners, together with national ensigns, weather signals and the International Code flags. It is issued in the two standard bindings—blue cloth with gilt edges and with the owner's name on the cover, and the plain yacht canvas.

ENGINEERING SPECIALTIES

Welin Davits on the Imperator

No marine lifeboat installation offers so many points of interest as that on the new Hamburg-American liner *Imperator*, made by the Welin Davit & Engineering Company, London. A feature which at once appears as a most striking innovation is the removal of a large number of the lifeboats from the top deck to the lower promenade deck, which is 20 feet below the boat deck. Besides the advantages affecting the stability of the ship by placing so many lifeboats on a lower deck, various other valuable points are gained, both from the lifesaving point of view and in other ways. Not only will the boats on the lower deck have a better chance of reaching the water safely, and the lowering operation occupy less time, but the risk of overcrowding the decks in time of danger will be greatly minimized. Furthermore, the space gained on the upper deck by placing the boats on a lower deck will be fully appreciated by the passengers. The principal mechanical feature of the arrangement is that one of the two davits is supported above the boat instead of socketing it at a point below, as is usual. The two davits are connected by a coupling rod attached to short cranks on the davits proper, so that the arms stand at every point parallel to one another, the boat travels parallel with its own axis and the tackles always remain in a vertical position.

Another special feature of the installation on the *Imperator* is the manner of controlling the lowering of the boats and the means for hoisting the boats on board again by electric power. Along the inboard side of the deck on which the boats are stowed runs a continuous shaft operated by an electric motor, and opposite each set of davits is a mechanical device operated by a single bar. As can be seen from Fig. 1, there are only two positions in which the bar can be moved—either forward or back. With the bar in one position the boat is lowered and in the other position the boat is hoisted. The apparatus works either for driving or lowering entirely by friction. The brake arrangement is so sensitive that the lowering speed cannot exceed 12 feet per second, and the brake handle, if accidentally dropped by the operator, automatically closes the brake, thus gradually checking the descent of the boat. The electric motors are used only for hoisting.

In order to keep the boat on an even keel while lowering, or to keep the boat level with the deck of the ship, a balanced fall adjuster is provided, which can be seen on one of the davit frames in Fig. 2. The standing part of each tackle is led over sheaves to the adjuster drum, and from 12 to 20 feet wound thereon in opposite directions. The drum is actuated by a self-locking worm, and when revolved pays out one fall and hauls in the other, approximately in equal lengths. In this way the falls are always under tension and all possibility of kinking is prevented.

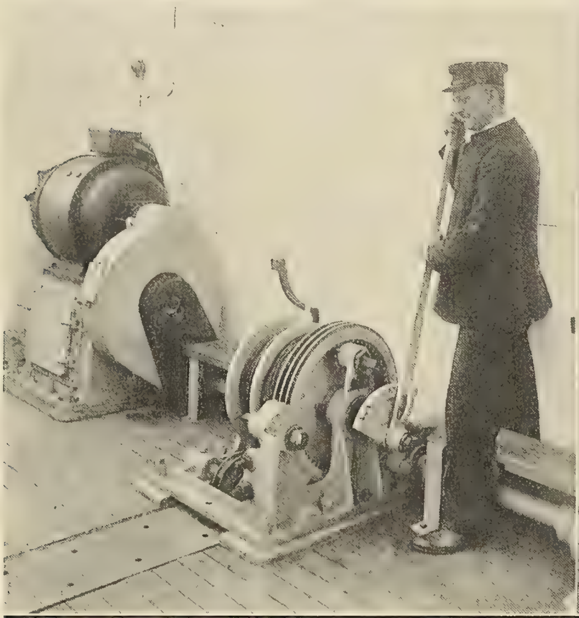


FIG. 1.—HOISTING AND LOWERING CONTROL

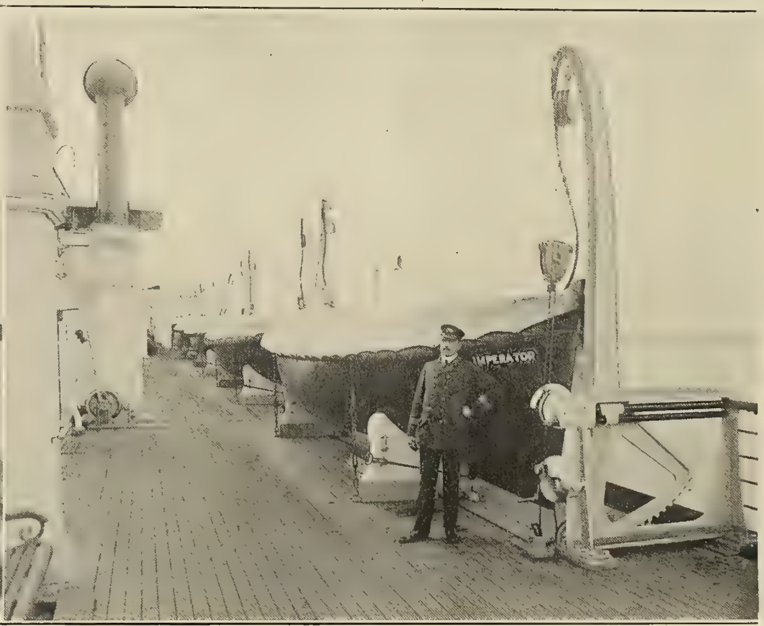
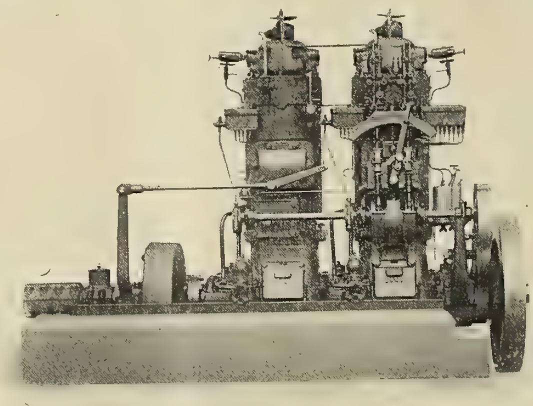


FIG. 2.—BALANCED FALL ADJUSTER ON DAVIT FRAME

The "Avance" Crude Oil Engine

The "Avance" crude oil engine, illustrated on this page, which is manufactured in Sweden, is placed on the market in England by Bovine & Company, Ltd., London, E. C. This engine is said to have been the first two-cycle engine to successfully use crude oil as fuel. The engine is guaranteed as suitable for running with any heavy oil which is lighter than water. It consumes oil as cheap as from 2¾ to 3d. per gallon, the fuel consumption being .57 pint per brake-horsepower-hour in ordinary commercial use, while an even lower fuel consumption has been reached on tests. It is also claimed that the consumption of lubricating oil is more economical than with the ordinary types of semi-Diesel and Diesel engines. At the Avance factory the manufacture of the engine was brought to a high standard of excellence, not only by the careful design and choice of materials, but also by the use of



up-to-date tools and a perfect system of jigs and gages throughout all departments. A most efficient method of direct reversing is employed by which the engine is automatically slowed down before the reverse action takes place. By thus providing effective cushioning the wear and tear which is likely to occur by reversing is avoided. A water-cooled injection valve is fitted to the engine, which safeguards the temper of the injection valve spring, thus doing away with a frequent source of trouble in this direction. The governing of the engine is very close, and is on the hit-or-miss principle, except in special electric lighting sets, where a sensitive centrifugal governor is employed. The engines are built in sizes from 3 to 320 brake horsepower.

Steel Furniture, Bulkheads, Doors and Trim for Battleships and Merchant Vessels

The first warships to have a complete equipment of steel furniture, doors and trim were laid down at Cramp's shipyard, Philadelphia, in 1898. These cruisers were the *Variag* and *Retvizan*, built for the Russian navy. Both were sunk off Port Arthur in the Russian-Japanese war, and after two years were raised by the Japanese. The steel furniture in both ships was found to be in good condition, and it is understood to be still in use by the Japanese navy. That enameled steel furniture can withstand the corrosive action of sea water under such extreme conditions is a striking illustration of the durability of the product and its suitability for naval construction.

DOUBLE BERTH, METAL DOOR AT RIGHT

BOOK CASE

LAVATORY BOARD

WARDROBE, SLIDING DOOR AT RIGHT

The development of steel furniture and trim for battleship use has been brought about by eminent naval architects, working through such well-known shipbuilders as the United States Navy Department, Cramp's shipyard, Philadelphia, Pa.; New York Shipbuilding Company, Camden, N. J.; Newport News Shipbuilding Company, Newport News, Va.; Fore River Shipbuilding Company, Quincy, Mass., and many others. This class of work has been built and installed by the Art Metal Construction Company, Jamestown, N. Y., and the photographs of typical battleship equipment reproduced on page 365 were obtained through the courtesy of this company.

One of the first considerations that led to the adoption of steel furniture by naval authorities is the complete sanitation afforded. Nearly all United States battleships and other naval vessels during the past fifteen years have had complete metallic equipment installed in the pantry and food storage apartments. Another consideration is the fact that steel furniture is "splinter proof." During the Spanish-American war more men were killed and injured during naval engagements by flying splinters of wood than any other cause. It is, therefore, evident that the elimination of woodwork throughout the entire ship is highly desirable as a factor of safety when vessels are in action. The substitution of steel for all interior woodwork and furniture renders flying splinters a thing of the past.

In merchant vessels equally striking advantages can be obtained by the use of metal furniture, trim and fittings, although in such ships the careful consideration of such matters as weight, cost, durability, strength, etc., is of first importance. In view, however, of the recent developments in steel construction in the manufacture of doors, windows, office partitions, furniture, etc., it is evident that the item of weight can be disposed of. While it is probable that the cost of finished steel is more than wood, yet it is possible, by the use of steel, to eliminate some parts of the structural work. This, together with the reduced cost of insurance against fire, should practically offset the greater cost. That light steel, properly treated, is durable, is attested by the fact that it has been used on battleships for a number of years and is now being used more extensively. The matter of strength is entirely up to the designer, since steel can be bent into such forms as will give the desired results. In fact, it seems wholly within the scope of possibilities to build the "joiner work" of vessels of steel instead of wood, rendering it practically impervious to fire. Added protection against cargo fires in merchant vessels can also be obtained by the installation of suitable fire partitions in the cargo spaces, together with the ordinary efficient fire fighting apparatus required by law.

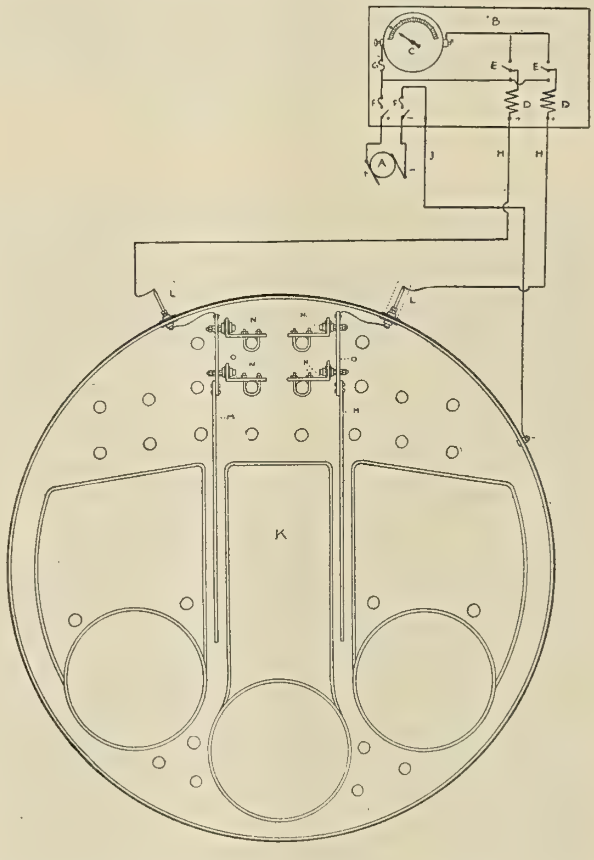
For decorative purposes any architectural effect desired can be obtained with metal in as good form as in any other material. Columns, capitals and all other forms of ornament can be made of the lightest woods, and then completely covered with a coat of copper or bronze of any desired thickness which will insure lasting qualities as well as absolute fire protection. Doors, frames, blinds, berths and all furniture in staterooms, offices, pantries, dining rooms, storerooms, etc., can be made of steel that is of less weight than wood and is also more durable. The cost of steel is not so far in excess of the cost of wood but that its use is permissible. For the simpler construction of stateroom bulkheads, corrugated plate can be used, the corrugations to be of such size and shape that they will afford all the stiffness required. Window and door frames of steel can easily be set in bulkheads of this kind. Sash, blinds and doors are now being made for various purposes, and they can be successfully applied to naval architecture.

For the more ornate staterooms and for dining saloons and lounging saloons, a steel plate construction can be used with moldings and ornament applied. The ornament can be of a very light-weight wood, or any other light-weight material, covered with copper or bronze by the electro-plating process. This process renders the wood absolutely fireproof, and does not add much to the weight. As the material employed in the ornamentation is rich in appearance, by its judicious use the amount of ornamentation to attain the desired result can be greatly reduced. The number of moldings can also be reduced. Stairs can be constructed of bent steel plates, and bronze or aluminum newels and balustrade. By the use of extruded bronze, of light weight but sufficiently strong, hand rails, tread nosings, etc., can be produced. Gallery facias can be made of light bronze steel moldings, and the gallery railings can be made as ornate as desired, and yet not have excessive weight, by the use of wrought steel of light members. In addition to the fire protection it affords, by the use of steel bulkheads the creaking which is always present in wood construction will be materially, and possibly entirely, eliminated.

Although no decrease in fire insurance rates has been published, as yet, by the Board of Underwriters for vessels completely equipped in steel, an understanding exists that vessels of the merchant marine equipped as outlined above will be privileged to receive very substantial reductions in insurance rates. It is even possible that the insurance rates will be cut one half, thus effecting a tremendous saving, not to mention the decreased cost of maintenance and absence of repairs.

The Cumberland Patent Process for the Protection of Metals

The Cumberland patent process for the protection of metals, manufactured by the Cumberland Syndicate, 44 Charing Cross, London, S. W., England, is an electrical process consisting of the use of one or more electrodes installed in a boiler, or other

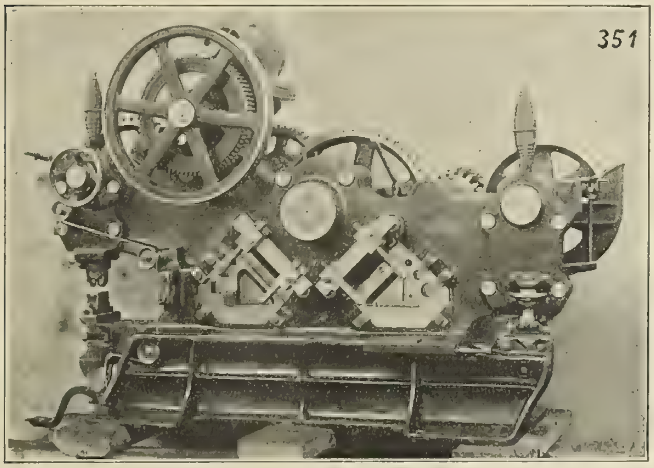


vessel, containing water and connected to the positive terminal of the direct-current supply, the boiler itself being connected to the negative terminal and the water forming the electrolyte. The illustration shows diagrammatically the apparatus which is used in this process and its arrangement in connection with the boiler. *A* is a motor generator; *B*, a switchboard; *C*, an ammeter; *D*, adjustable resistances; *EE*, two-way switches;

FF, double-pole switches and fuses; *HH* are the wires from the positive pole of the apparatus to the insulated poles, *LL,* in the shell of the boiler, which conduct the current to the detachable iron electrodes, *MM,* attached to the steam space stays, *NNN,* while *J* is the wire from the negative pole to the boiler shell. The results from experiments by competent authorities and from actual experience in service, it is claimed, show that this process stops corrosion in boilers or other metal vessels containing water; that it removes scale from the heating surface of a boiler, and also prevents scale from forming; and it is also a safe water alarm; for if an electrode is placed horizontally in a boiler just above the danger zone for low water, and lights are placed in the circuit with the current through them, the lights will go out when the electrode is not immersed in the water, and, consequently, will give a positive indication of low water in the boiler. For the operation of the apparatus only enough voltage is required to overcome the resistance through the water and to overcome any electromotive force due to the difference of potential of the metals comprising the boiler when they exist. Too high voltage, however, gives no harmful results on the boiler, but merely increases the action on the electrode, requiring it to be removed more frequently. It is claimed that the apparatus requires practically no attention after once being properly installed and started.

"Imperator" Quadruple Combination Machine

The Wiener Machinery Company, New York City, American managers for the Oeking Company, Dusseldorf, Germany, have placed on the market a quadruple combination machine under the name of the "Imperator." The design of this machine was brought about by the success achieved with the Oeking solid steel frame triple combination machines which have been on the market for some time past. Many inquiries



were received for a combination machine which could miter right and left angles without any change of knives, and it is also found that a market exists for machines which, besides cutting and mitering angles, rounds and squares, would also cut beams and channels.

The new type of the Oeking solid steel frame quadruple combination machine, styled "Imperator," is therefore built to combine in one frame ready for work all the tools for almost any kind of cutting, shearing, coping, mitering and notching. The fact that the frame is one massive piece of steel permits a compactness which will make it a most suitable and economical tool for crowded shops. It is also particularly suited for plants where driving power is limited.

The machine illustrated is capable, without any change of tools, of splitting plates of unlimited length, or cutting flat bars, shearing off rounds and squares, cutting and mitering angles and tees, both right and left at any degree, and of punching plates and structural material, both webs and flanges. With interchangeable tools, beams and channels or any other shape can be cut. The punching tools can also be interchanged for coping, mitering, etc.

The machines are built in three sizes, and can be furnished with tight and loose pulley for belt drive or can be arranged for direct-motor drive. If it is desired the machines can be equipped on a turntable to facilitate mitering long bars of angle iron. It is claimed that these machines do not cost more than the equivalent equipment in single machines, and that they are, furthermore, very economical in operation, saving both time and labor.

The Martin Patent Davit

The Martin patent davit, manufactured by Sir W. G. Armstrong Whitworth & Company, Ltd., is a davit of simple construction, built of steel angles and plates, combining lightness with strength and operated by direct adaptation of the crane and winch principle. The working parts of the davit are practically the same as those used in an ordinary winch, so that little instruction is needed to operate the davits, and the working parts are inclosed in a watertight compartment, which

thoroughly protects them from damage by the weather. To swing the davit outboard it is simply necessary to turn a crank, while a brake control is provided for lowering the lifeboat. A separate mechanism is provided for hoisting the lifeboat from the water. Wire fall are used, which does away with the constant renewal of the old type manilla falls and prevents the twisting or fouling of the falls after the boat is launched. Where the lifeboats are double banked, or carried across the deck, a skid is provided, consisting of two trackways, on each of which runs a carrier fitted with chocks to hold the lifeboat. These carriers are connected with a shaft, and by turning a crank which actuates a worm gear the shaft is revolved and the boat is run out under the davit. Thus one set of davits is capable of handling several boats. The lifeboats are lowered at both ends in unison, so that the lifeboat reaches the water on an even keel. These davits are sold exclusively by Messrs. Ogilvy, Gillanders & Company, London and Liverpool.

STATEMENT OF THE OWNERSHIP, MANAGEMENT, CIRCULATION, ETC., of International Marine Engineering, published monthly at New York, N. Y., required by the Act of August 24, 1912.
Editor, H. H. Brown, New York; managing editor, H. L. Aldrich, New York; business manager, H. L. Aldrich, New York.
Publisher, Aldrich Publishing Company, New York.
Owners: H. L. Aldrich, New York; M. G. Aldrich, New York.
Bondholders: A. L. Aldrich, Rhode Island; J. W. Reno, New York; Geo. Slate, Summit, N. J.; E. L. Sumner, Flushing, N. Y.
H. L. ALDRICH.
Sworn to and subscribed before me this 13th day of June, 1913.
(Seal) GEORGE E. MULLER,
Notary Public.
(My commission expires March 30, 1915.)

SELECTED MARINE PATENTS

The publication in this column of a patent specification does not necessarily imply editorial commendation.

American patents compiled by Delbert H. Decker, Esq., registered patent attorney, Loan & Trust Building, Washington, D. C.

1,062,181. COLLAPSIBLE LIFE-BOAT. SOPHUS NYBOE, OF BROOKLYN, NEW YORK.

Claim 3.—In a collapsible boat the combination of two non-collapsible sides, means for folding the same together along the keel line, a collapsible bottom and vertical collapsible partitions for separating the space below the said decks and the said bottom from the interior of the boat. Nine claims.

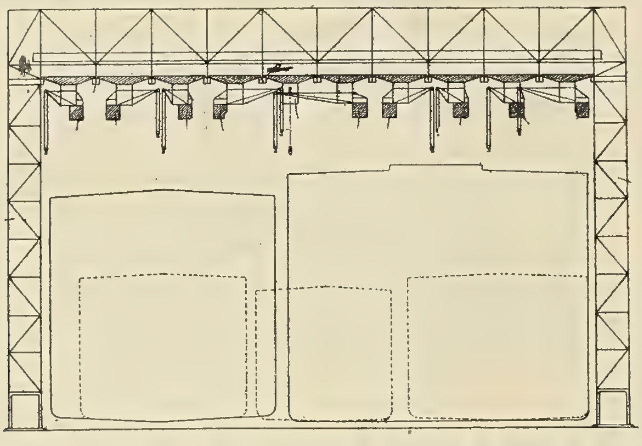
1,061,309. SHIP'S LOG. THOMAS H. McQUOWN, OF CAMBRIDGE, MASS.

Claim 1.—In a ship's log, the combination with a frame of flexible means to tow said frame in close proximity to the hull of a vessel, whereby said frame is free to move laterally in any direction independently of the vessel, an actuator flexibly sustained by the frame and operated by its movement through the water, an indicator situated at a distance from the actuator and means to operate the indicator by the actuator, said frame having means to prevent the actuator from contacting with the vessel. Twenty-three claims.

British patents compiled by G. F. Redfern & Company, chartered patent agents and engineers, 15 South street, Finsbury, E. C., and 10 Gray's Inn Place, W. C., London.

19,781. IMPROVEMENTS IN AND RELATING TO SHIPBUILDING SLIPS. W. E. EVANS OF LONDON, W. C.

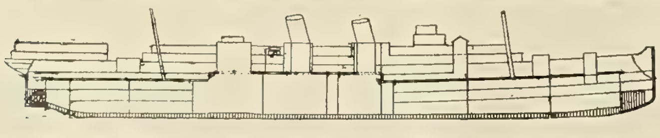
Claim.—Slips for ships, according to this invention, are provided with a number of weight-raising appliances movable along the length of the slip, and a number of rotatable traveling cranes are provided side by



side in such a manner that (considering the area of the slip to be divided into a number of longitudinal strips or "work areas" for each of which a crane is provided) each crane can serve the "work areas" of each of the adjacent cranes either partly or completely so that it is possible wholly to serve the "work area" of any crane in use or disabled by employing the adjacent cranes working together or a single adjacent crane, for the whole length and breadth of the slip.

10,201. IMPROVEMENTS IN THE CONSTRUCTION OF SHIPS. J. MACKINTOSH, OF PAISLEY, SCOTLAND, AND H. MOWATT, OF OXTON, BIRKENHEAD.

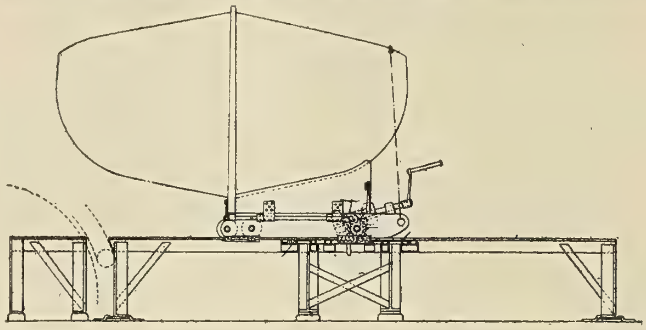
Claim.—The ship is constructed with an air-tight deck or decks, and with means for closing all the deck openings, in horizontal planes, or



levels, so that should the vessel be punctured below the levels or decks and bulkheads, it would be possible, by closing at these levels all the holes communicating with the punctured compartment or compartments, to prevent the escape of the contained air and thus to prevent water from rising indefinitely. Ships thus constructed are also fitted with air pumps connected to the ordinary bilge and ballast services or to one or other of these so that they, while generally in use for the ordinary purposes for which they are installed, may also be used in conjunction with the air pumps or compressors, to supply air to, as well as to draw water from, the compartments to which they are connected. Some of the air-tight compartments may be detached at will and left air-tight. A chemical substance evolving gas in contact with water, with air, or both, may be discharged into the air-tight compartments to form the gas necessary for expelling the water; or gas otherwise generated may be used.

13,777. IMPROVEMENTS IN APPARATUS FOR LAUNCHING AND CHOCKING BOATS. SIR W. G. ARMSTRONG, WHITWORTH & CO., LMTD., AND A. J. LEWKOWICZ, OF NEWCASTLE-UPON-TYNE.

Claim.—This invention relates to improved arrangements on board ship for handling boats which are supported on cradles, moving on ways or tracks. A cradle travels on two athwartship ways, which are hinged



so that they can be turned into positions shown in dots to obstruct the deck as little as possible. The cradle is provided with a pinion actuated by a handle and worm gear and meshing with the racks formed by perforations along the upper surface of the ways so that the boat carried by the cradles can be moved in or out by turning the handles.

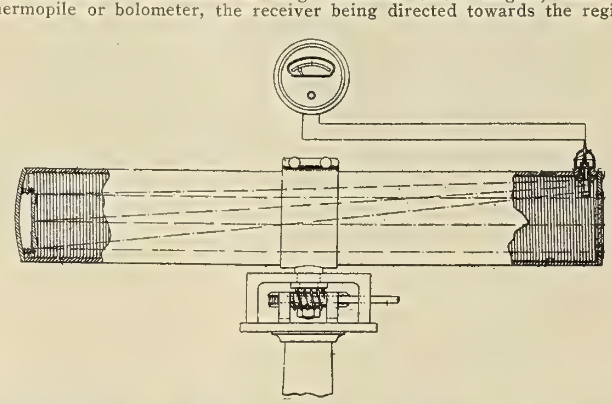
18,239. "IMPROVEMENTS IN THE CONSTRUCTION OF BULKHEADS FOR SHIPS." H. MOWATT OF BIRKENHEAD.

Claim.—To construct bulkheads in ships of greatly increased strength and resistance to collapse, without appreciably diminishing the cargo

capacity of the hold, horizontal girders are attached to the bulkheads and to the sides of the ship at intervals, such girders being wider at the center than at the ends, and vertical girders are attached at intervals to the horizontal girders.

10,576. IMPROVEMENTS IN MEANS FOR DETECTING THE PRESENCE AT A DISTANCE OF ICEBERGS, STEAMSHIPS, AND THE LIKE. A. HILGER, LTD., AND L. BELLINGHAM, BOTH OF 75A CANDEN ROAD, LONDON, N. W.

Claim.—This invention relates to apparatus for detecting the presence at a distance of ice bergs, etc., and consists primarily in the use of a radiation receiver sensitive to long infra-red wave lengths, such as thermopile or bolometer, the receiver being directed towards the region



which it is desired to search and being connected with one or more indicators actuated by the changes in E. M. F. of the thermopile, or the changes being due to variations in the radiation of energy to or from the receiver due to the presence of cooler or warmer bodies in its field of view.

2,883. AN IMPROVED APPARATUS FOR USE IN THE COALING OF SHIPS OR LIKE OPERATIONS. J. ROBERTSON, OF 94 WINDSOR ROAD, FOREST GATE, ESSEX.

Apparatus for coaling ships comprises broadly a pontoon having platforms between and to which the barges can be anchored, a vertically adjustable travelling bucket elevator supported by a structure carried by the pontoon adapted to depend into a positioned barge, a chute carried by the elevator and adjustable in position relative to it, means, carried by the adjustable chute being provided for tipping the buckets of the elevator as they pass the chute. Provision is made for holding the buckets in the normal position until they reach the discharging position substantially as specified.

International Marine Engineering

Published Monthly by ALDRICH PUBLISHING CO.

17 BATTERY PLACE, NEW YORK — **31 CHRISTOPHER ST., LONDON, E. C.**

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Edited by H. H. Brown, A. M. Inst. N. A.
Member Soc. N. A. and M. E.

Vol. XVIII — **SEPTEMBER, 1913** — **No. 9**

Old Dominion Line's Freight Steamer Tyler

A single screw freight steamer, in which are incorporated some unusual features of design, has just been built for the Old Dominion Steamship Company, New York, by the New York Shipbuilding Company, Camden, N. J. The *Tyler*, as the new vessel is named, is fitted out entirely as a freight carrier; classed A-1 in the American Bureau of Shipping, and is the only vessel of the Old Dominion fleet that will be used exclusively for freight. Hitherto the service of this company between New York and Norfolk has been carried on by passenger ships, but with the advent of the new vessel the capacity of the line for handling miscellaneous freight expeditiously will be materially increased.

An unusual feature in the design of the vessel is the bulbous form of the bow, which was adopted after a series of model tests were made to determine the form which would best meet the requirements of the vessel for speed and power. This form of bow hitherto has been adopted only in the battleships and large cruisers.

The hull is built of steel throughout to the following dimensions:

Length over all	344 feet.
Length on waterline	331 feet.
Beam, molded	47 feet.
Depth, molded	26 feet 7 inches.
Depth, molded to hurricane deck	35 feet.

FIG. 1.—FREIGHT STEAMER TYLER FOR THE OLD DOMINION LINE

The hull is divided by five watertight bulkheads into six watertight compartments, and has four decks, namely, the orlop, lower, main and hurricane, with deck houses amidships. The propelling machinery is also located amidships. Details of the construction of the hull can be seen from the amidship section and general plans shown in Figs. 2 and 3.

Fourteen cargo ports are fitted, six between the lower and main decks, port and starboard, and eight between the main and hurricane decks, port and starboard. Gangway doors are fitted abreast the large cargo hatches in way of the well forward. Large cargo hatches are also fitted to the forward and after holds with two freight elevators between the hold and the main deck and one freight elevator between the hold and the hurricane deck.

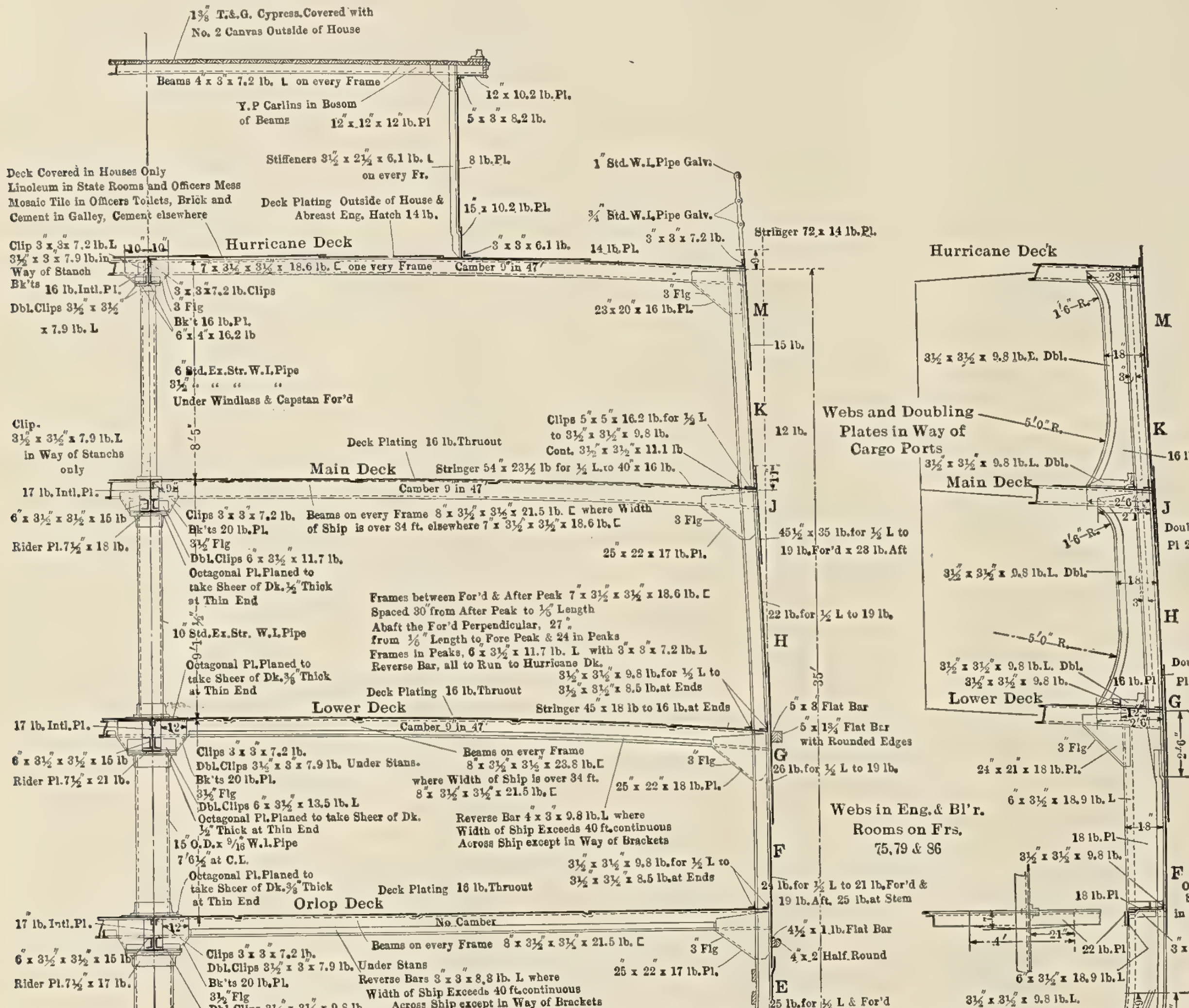

FIG. 2.—MIDSHIP SECTION

Freight is handled by two 10-ton steel booms on the foremast and one 3-ton and two 5-ton wooden booms on the mainmast. For working the cargo, four powerful Lidgerwood steam winches are fitted, two at the foremast and two at the mainmast, with smaller winches of the Lidgerwood type fitted at each elevator hatch to handle the lighter cargo. The remaining deck machinery consists of a Hyde windlass and capstan forward and two capstans aft. Steering is by a quadrant on the hurricane deck with leads running forward to the steering engine amidships.

GENERAL ARRANGEMENT

On the bridge deck, forward, there is a pilot house, aft of which are the captain's room and baths for both the captain and the officers; then a light and air shaft extending to the galley on the hurricane deck below. Aft of the air shaft on the starboard side are the officers' quarters, and on the port side the wireless room and the quarters for the wireless operator and quartermaster, besides a spare stateroom on both the starboard and port sides.

Forward of the stack on the hurricane deck there are two separate houses with a passageway between; the forward one, which is 44 feet long and 24 feet wide, contains the officers' mess, aft of which are the stewards' quarters, refrigerators

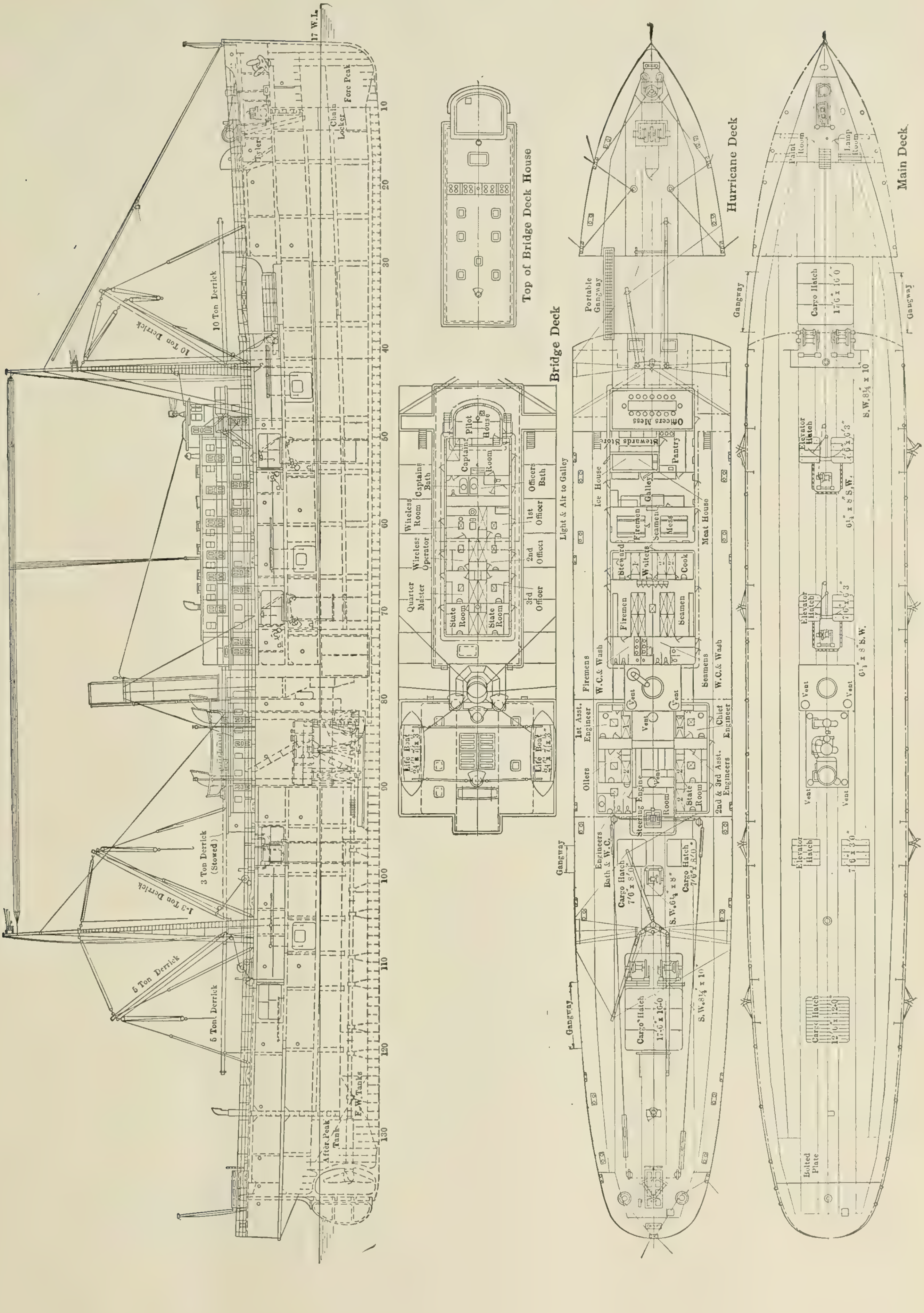

FIG. 3.—GENERAL ARRANGEMENT PLANS

and pantry and then the main galley, aft of which again are the firemen and seamen's mess. In the second deck-house on the hurricane deck are rooms for the steward, waiters, cook and quarters for the firemen and seamen.

Aft of the stack, and located around the engine room casing, are the rooms and baths for the engineers and oilers, together with a spare stateroom on the starboard side. Right aft of the engine casing is the steering engine room.

The main deck, with the exception of the engine and boiler casings, and fore and after peaks, is devoted exclusively to freight.

Propelling Machinery

Propulsion is by a single screw, driven by a three-cylinder, triple-expansion engine, 19¾, 33¼ and 58 inches diameter by 42 inches stroke, operating at a normal speed of 100 revolutions per minute. From the sectional drawings of the main engine, shown in Figs. 4 and 5, it will be noted that piston valves are fitted to the high-pressure and intermediate-pressure cylinders, being placed between the two cylinders, while a double-ported slide valve is fitted to the low-pressure cylinder, together with a Lovekin assistant cylinder. All of the piston rods are 5¼ inches diameter and the crankshaft 12 inches diameter.

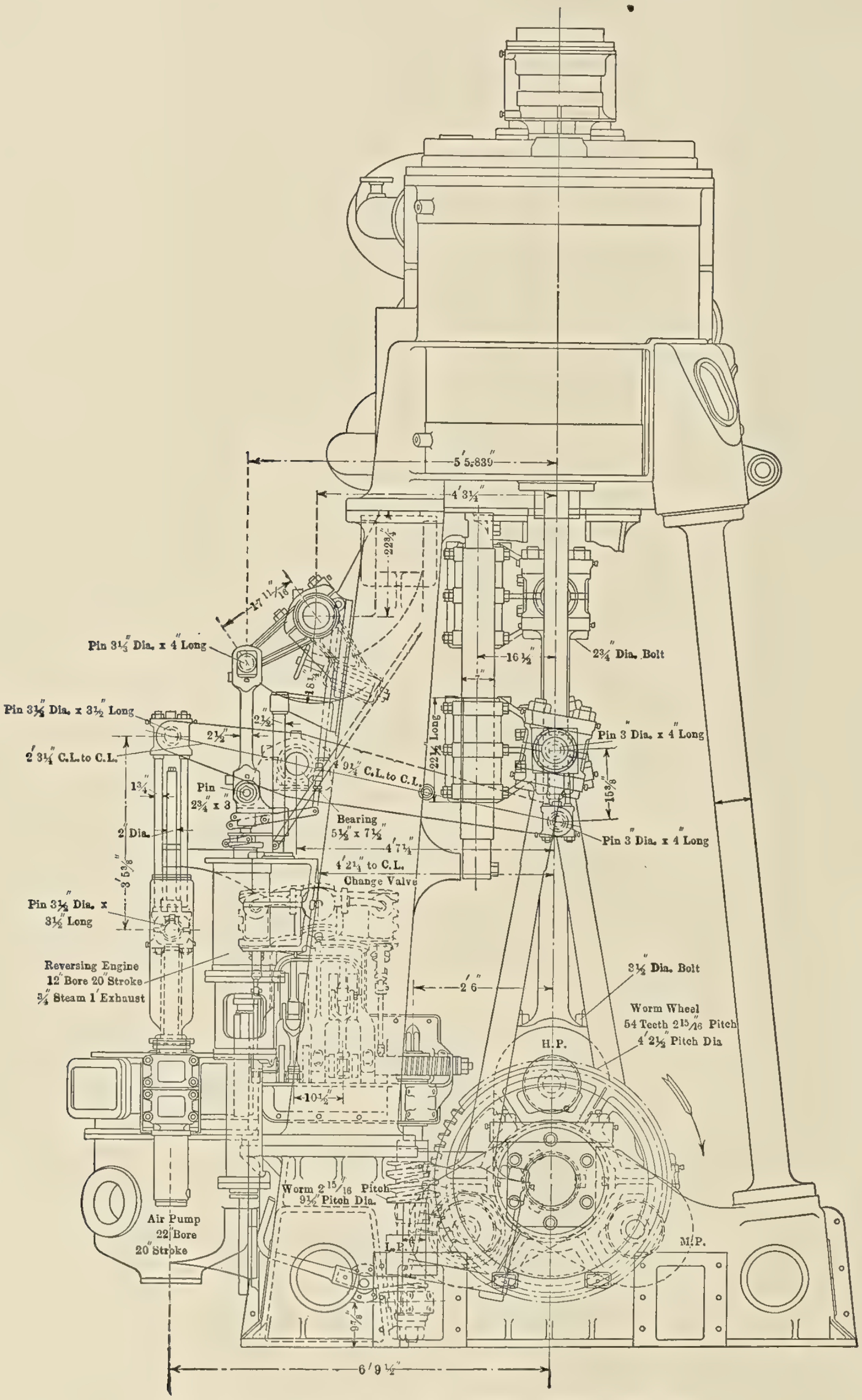

FIG. 4.—END ELEVATION OF MAIN ENGINE, LOOKING FORWARD

The main air pump, 22 by 20 inches, together with two bilge pumps, 4½ by 20 inches, is worked off the intermediate-pressure crosshead. The main engine auxiliaries consist of a two-cylinder, 6 by 6 by 6-inch turning engine and a 12 by

20-inch reversing engine, with an oil cylinder 6¼ by 20 inches, and also an evaporating pump 1¾ inches by 9 inches, operated from the rocker arm of the main air pump.

Steam is supplied by two single-end Scotch marine boilers, 13 feet 6 inches diameter by 12 feet long, located in a single fire-room and separated from the engine room by a screen bulkhead. Coal is placed in wing bunkers abreast the boiler blower and a fresh water tank fitted with a 4½ by 2¾ by 6-inch horizontal Blake fresh water pump. On the port side of the engine room are the main condenser, with a 10-inch centrifugal circulating pump, driven by a 6 by 6-inch engine, together with the feed-water tank and a Schutte & Köerting feed-water heater. The main and auxiliary feed pumps are both of the Blake vertical type, 12 by 7 by 16 inches. The

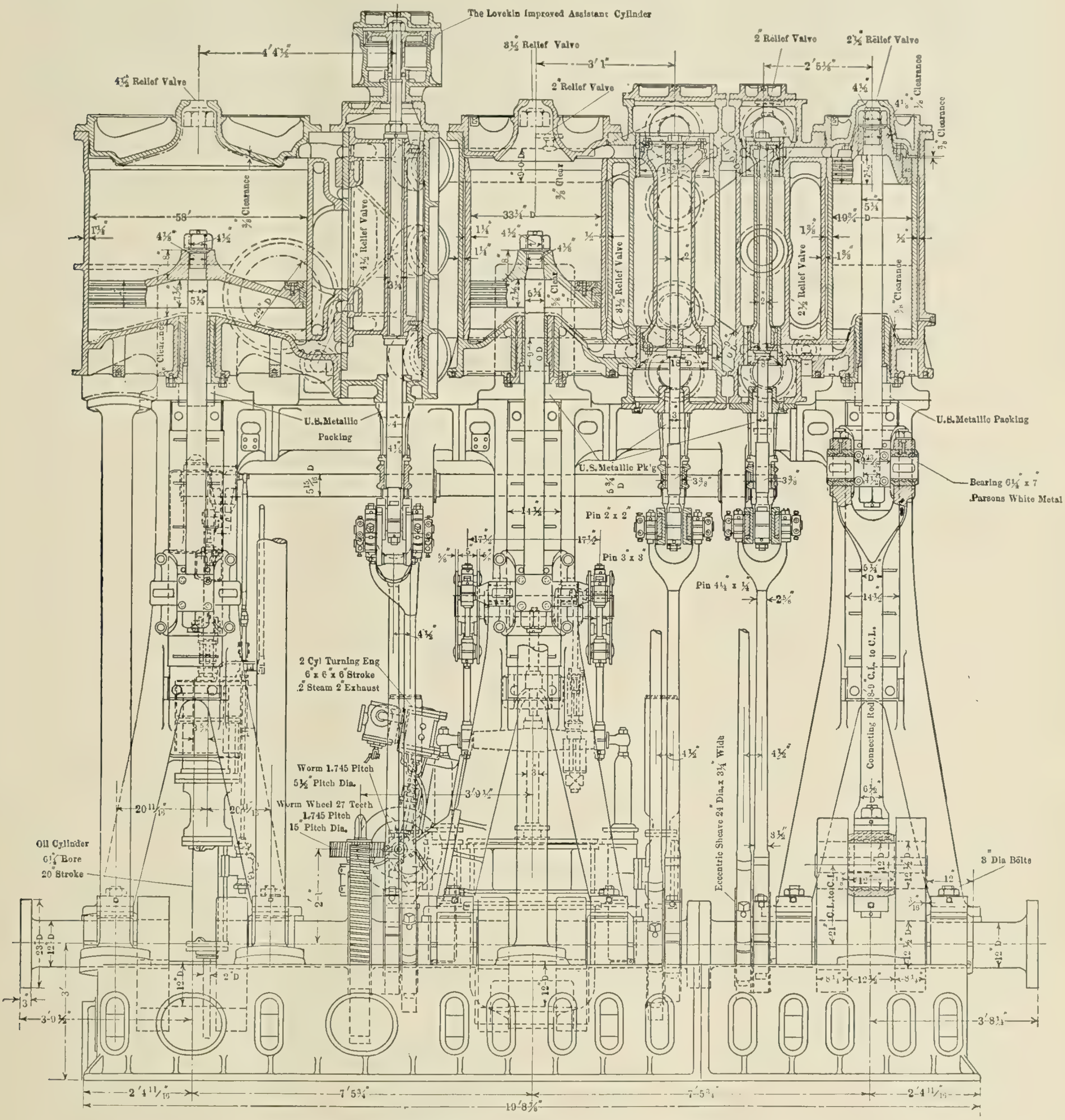

FIG. 5.—SECTIONAL ELEVATION OF MAIN ENGINE OF THE FREIGHT STEAMER TYLER

room on both the port and starboard sides, extending a short distance into the engine room. A vertical donkey boiler, 4 feet diameter by 8 feet high, is located on the main deck above the boiler room.

All the auxiliary machinery in way of pumps, heaters, filters, etc., are of a very complete and up-to-date character. On the starboard side of the main engine room is the engine-driven donkey boiler feed pump is a horizontal Worthington pump, 4½ by 2¾ by 4 inches. The other auxiliaries include a 14 by 8½ by 12-inch Blake donkey pump and a 6 by 6 by 12-inch Blake horizontal sanitary pump.

Fresh water is carried in built-in tanks aft. The trim of the ship is maintained by tanks in the forward and after peaks. The vessel was designed for a speed of 12 knots at sea, but on her trial trip a speed of 12¾ knots was obtained with the vessel loaded to her designed draft and carrying between 2,600 and 2,700 short tons of freight.

Launch from the Middleton Shipyard

On Tuesday, July 8, Messrs. Irvine's Shipbuilding & Dry Docks Company, Ltd., launched from their Middleton shipyard the steel screw steamer *Manchester Civilian,* built for Messrs. The Manchester Liners, Ltd., Manchester.

The dimensions of the vessel are 400 feet in length by 52 feet beam extreme by 29 feet 6 inches depth molded, carrying over 8,000 tons on a moderate draft. She is built to British Corporation Classification, having a single deck of steel, with poop, bridge and forecastle, and water ballast is carried in the cellular double bottom and fore and afterpeak tanks, the tank under the engines and boilers being arranged for trimming.

The vessel is constructed with deep frames, without side stringers, giving exceptionally clear holds for the carriage of bulky cargoes, and is divided into seven watertight compartments by six transverse bulkheads. Wood grain divisions are fitted throughout to Board of Trade regulations. Four large hatches are provided and a cross bunker hatch, together with all the latest facilities for the rapid loading and discharging of cargo, including ten special type steam winches exhausting to a contraflo winch condenser, and twelve Mannesmann steel derricks. A powerful quick-warping steam windlass is fitted forward, and combined steam and hand-steering gear is fitted aft (Wilson & Pirrie type), with telemotor attachment to the bridge amidships.

The machinery, which has been constructed by Messrs. Richardsons, Westgarth & Company, Ltd., Hartlepool, consists of a set of "Richardsons" standard triple-expansion engines, with cylinders 25 inches, 40 inches and 68 inches by 48 inches stroke, steam being supplied by three large single-ended boilers, working under natural draft at a pressure of 180 pounds per square inch. The specification is very complete, and embraces contraflo main and auxiliary condensers, and a Cascade feedwater filter and heater, in which the whole of the auxiliary exhausts are utilized for feed heating. The auxiliaries include a Morison evaporator, large ballast pump, vertical auxiliary feed pump float, controlled from the Cascade filter, and independent pump for the auxiliary condenser. In the stokehold Diamond blowers are fitted for cleaning the boiler tubes, and the fire-doors and the furnace fittings are of special design. The propeller is of the solid four-bladed type, and made entirely of manganese bronze.

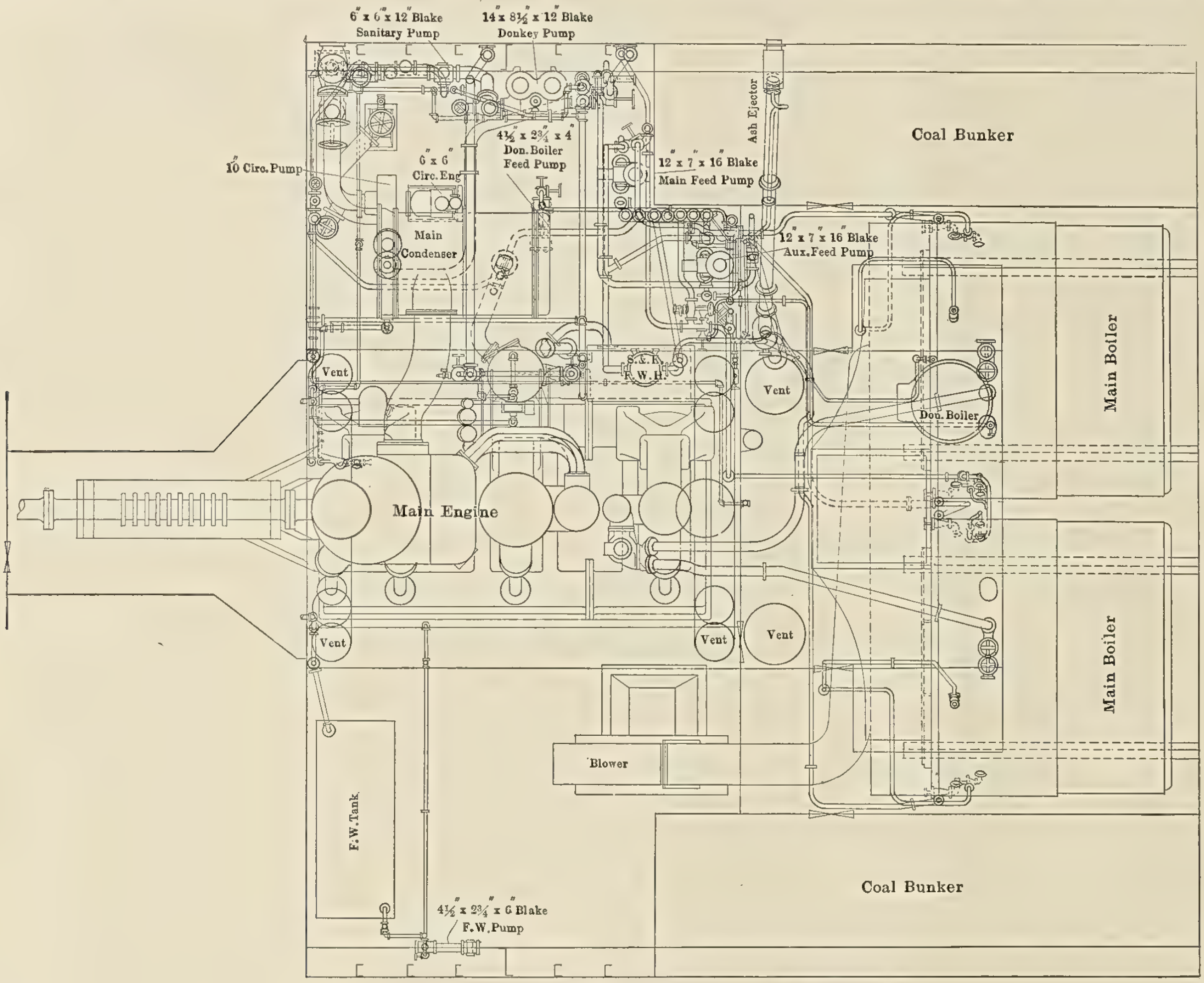

FIG. 6.—PLAN OF MACHINERY ARRANGEMENT OF THE TYLER

Chinese Ship Built to American Rules.—According to a report from the Consul-General at Hongkong, a twin-screw steel steamer, 217 feet in length over all, 38 feet beam and 12 feet depth, is being built in one of the Hongkong shipyards for non-American citizens and for use in non-American trade under the rules and specifications of the American Bureau of Shipping. The owners of the vessel are the Sze Yup Steamship Company, of Hongkong, and the vessel will be used in the trade between Hongkong and Kongmun, the Chinese port in the Pearl River Delta, which is the port for the districts from which the vast mass of the Chinese in the United States come. Accommodations will be provided on the ship for first class European passengers and first, second and third class Chinese passengers. There will also be ordinary accommodations for about 1,100 Chinese passengers, and the vessel will be finished in about eleven months. The company owns and operates three other vessels in their trade, but the other vessels were built to English specifications.

Progress of U. S. Naval Vessels

The Bureau of Construction and Repair, Navy Department, reports the following percentage of completion of vessels for the United States navy:

	Tons.	Knots.		May 1.	Aug. 1.
BATTLESHIPS					
New York	28,000	21	Navy Yard, New York	77.2	85.8
Texas	28,000	21	Newport News Shipb'g Co.	88.4	91.7
Nevada	28,000	20½	Fore River Shipb'g Co.	29.3	40.3
Oklahoma	28,000	20½	New York Shipb'g Co.	26.0	37.7
Pennsylvania	....	....	Newport News Shipb'g Co.	00.0	2.0
TORPEDO BOAT DESTROYERS					
Cassin	742	29½	Bath Iron Works	87.2	99.3
Cummings	742	29½	Bath Iron Works	81.2	90.4
Downes	742	29½	New York Shipb'g Co.	47.5	63.7
Duncan	742	29½	Fore River Shipb'g Co.	79.0	98.0
Aylwin	742	29½	Wm. Cramp & Sons	92.1	96.9
Parker	742	29½	Wm. Cramp & Sons	89.2	93.5
Benham	742	29½	Wm. Cramp & Sons	87.9	92.3
Balch	742	29½	Wm. Cramp & Sons	88.5	91.8
O'Brien	742	29½	Wm. Cramp & Sons	1.3	7.1
Nicholson	742	29½	Wm. Cramp & Sons	1.2	7.3
Winslow	742	29½	Wm. Cramp & Sons	1.2	7.0
McDougal	742	29½	Bath Iron Works	4.4	12.6
Cushing	742	29½	Fore River Ship'g Co.	8.9	12.6
Ericsson	742	29½	New York Shipb'g Co.	5.0	9.6
SUBMARINE TORPEDO BOATS					
G-4	....	....	Wm. Cramp & Sons	88.4	93.4
G-2	....	....	Newport News Shipb'g Co.	87.2	88.1
H-1	....	....	Union Iron Works	90.4	94.5
H-2	....	....	Union Iron Works	90.0	93.0
H-3	....	....	Seattle Con. & D. D. Co.	88.0	91.4
G-3	....	....	Lake T. B. Co.	67.4	69.6
K-1	....	....	Fore River Shipb'g Co.	76.6	85.9
K-2	....	....	Fore River Shipb'g Co.	76.8	85.0
K-3	....	....	Union Iron Works	75.6	81.6
K-4	....	....	Seattle Con. & D. D. Co.	75.0	78.6
K-5	....	....	Fore River Shipb'g Co.	58.7	72.9
K-6	....	....	Fore River Shipb'g Co.	57.1	72.7
K-7	....	....	Union Iron Works	65.3	71.9
K-8	....	....	Union Iron Works	63.4	71.0
L-1	....	....	Fore River Shipb'g Co.	00.0	6.1
L-2	....	....	Fore River Shipb'g Co.	00.0	6.1
L-3	....	....	Fore River Shipb'g Co.	00.0	6.1
L-4	....	....	Fore River Shipb'g Co.	00.0	5.5
M-1	....	....	Fore River Shipb'g Co.	00.0	00.0
COLLIERS					
Proteus	20,000	14	Newport News Shipb'g Co.	90.7	100.0
Nereus	20,000	14	Newport News Shipb'g Co.	87.1	93.6
Jason	20,000	14	Maryland Steel Co.	98.8	100.0
Jupiter	20,000	14	Navy Yard, Mare Island	99.1	100.0
Kanawha	14,000	14	Navy Yard, Mare Island	00.0	1.3
Maumee	14,000	14	Navy Yard, Mare Island	00.0	1.3

Mine Layers Cerbère and Pluton

The French admiralty has recently constructed two mine layers to take up the work carried on hitherto by old destroyers, which were altered for the purpose. The appearance of the new vessels resembles that of a big trawler, and they are so designed that the submarine mines, of which there are 140, are trimmed on the main deck on four railway lines, ready for launching through two specially large doors in the stern of the vessel. These mines, which are of the Sauter-Harle pattern, are so constructed that they will remain at a depth of 13 feet below the surface of the water. The boats are further armed by one 3-pounder gun, located forward.

The general dimensions of the boats are:

Length over all	199 feet 5 inches.
Length between perpendiculars	193 feet 7 inches.
Breadth	27 feet 3 inches.
Depth	14 feet 2 inches.
Draft at stern	10 feet 8 inches.
Displacement, full load	594 tons.
Displacement, on trial	541 tons.

The hulls are of Siemens-Martin steel, and the keel, 131 feet in length, of teak. On each side of the center keelson are five keelsons amidships, and towards the ends the number is reduced to three. Bilge keels, 10 inches deep, have been worked for about 80 feet amidships. The hull is divided into ten watertight compartments. The officers are berthed forward and the crew aft.

Steam is supplied to the main engines and auxiliaries by two watertube boilers, operated under forced draft. The main engines consist of two reciprocating engines, driving screw propellers. Particulars of the engines and boilers will be found in Table I. Electricity is supplied by a 4-kilowatt dynamo. A Thirion pump, with a capacity of 15 tons of water per hour, is also supplied.

It is worthy of note that the ordinary bunkers have been worked on both sides of the boiler rooms, and extra bunkers are located alongside the engine-rooms; therefore the vital parts of the ship are in a measure protected. Two rudders are fitted, one forward and one aft, having surfaces of 50 to 24 square feet, respectively.

Table I.—Boilers and Engines.

	Cerbère.	Pluton.
Boilers:		
Type	du Temple.	Normand.
Number	2	2
Grate surface	151 sq.ft.	148.55 sq. ft.
Heating surface	5,647	6,927
Pressure	256 pounds.	256 pounds.
Fans	2 Rateau.	2 Rateau.
Bunkers	145 to 190 tons.	145 to 190 tons.
Acting radius	1,900 miles at 16 knots.	
Main Engines:		
Diameters of cylinders	19, 29 and 48 ins.	19, 29 and 48 ins.
Stroke	23 ins.	23 ins.
Revolutions	260	260
Indicated horsepower	3,000	3,000
Propellers:		
Diameter	8 ft. 3 ins.	8 ft. 3 ins.
Pitch	9 ft. 4 ins.	9 ft. 4 ins.

Table II. Four-hour Full-power Trial.

	Cerbère.	Pluton.
Mean speed	20 knots.	20.87 knots.
Best run	21.695 knots.	21.50 knots.
Consumption, contract, per square foot grate, per hour	81 pounds.	81 pounds.
on trial	71 pounds.	77 pounds.
per indicated horsepower	1.80 pounds.	1.86 pounds.
Revolutions	278.10	272.4

Table III. Eight-hour Trial at 16 Knots.

Mean speed	16.45 knots.	16 knots.
Consumption, contract, per square foot grate, per hour	21 pounds.	21 pounds.
on trial	17 pounds.	17 pounds.
per indicated horsepower	1.20 pounds.	1.40 pounds.
Revolutions	202.5	192.5
Builders	Chantier de Bretagne.	Chantier A. Normand.

Performance of the Lumber-Carrying Steamer Adeline Smith

The steam lumber-carrying vessel, *Adeline Smith*, described on page 331 of International Marine Engineering for August, 1912, was built by the Newport News Shipbuilding Company, Newport News, Va., to the designs of Edward S. Hough, San Francisco, Cal., and is now on her regular runs between the Oregon lumber mills of the C. A. Smith Lumber Company, owners of the vessel, and their yards in San Francisco Bay. This steamer is, therefore, of special interest to those engaged in the lumber mill industry and transportation by water, inasmuch as she is a link which completes the chain of operations in one of the most systematic lumber companies at the present time.

By referring to the drawings published in the August, 1912, issue, it will be noted that the vessel is not provided with cargo-handling gear, except for two booms forward, which are used to handle the company's mill freight only. The absence of cargo-handling gear is accounted for by the fact that at the lumber mills in Oregon, and at each of the extensive yards of the Smith company in San Francisco Bay, there are overhung electric travelers, with trolleys arranged so that the vessels can be loaded and discharged without the use of any gear on board.

The mill products of the Smith company are handled in units of standard size from the sorting sheds of the mills to the wharves at the company's yard, where it is distributed in the original units by the company's own bay and river craft to the various yards and landings of the purchasers. All of the seagoing steamers are discharged at one wharf and proceed to sea immediately. The lumber units are 4 feet by 4 feet square, made up in varying lengths and up to 8 tons weight. The units are lowered into their places in the holds of the vessels and on deck by the electric travelers, and require no further handling after leaving the crane hook. The time, therefore, that is required to load or to discharge the *Adeline Smith* is a simple calculation of the number of trolleys available and the speed of lifting and lowering.

Hitherto it has been, and still is, the general custom for the seagoing lumber steamers to land their cargoes in lots as required at the different wharves convenient to or on the property of the lumber yards. This is a slow and expensive process for the vessel, and is entirely avoided by the system developed by the Smith company.

On the *Adeline Smith* the holds and decks are designed to accommodate a given number of lumber units to the extent of 2,000,000 feet, board measure, allowing 80 percent efficiency of stowage below decks and 84 percent on deck. Liquid fuel is used on the vessel, as is customary on all of the steamers in this particular trade; but contrary to the usual custom of storing the fuel in the double bottom, where the loose liquid has been found a disturbing factor in the operation of a lumber vessel carrying the usual high deck loads, especially in heavy weather with a beam sea, the *Adeline Smith* is fitted with a central fuel tank, designed to overcome the disturbing factor.

Reference to the drawings of the *Adeline Smith*, published in the August, 1912, issue of International Marine Engineering, shows that the free surface of the liquid fuel carried in the contracted thwartship tank is very small, and, therefore, practically negligible as a disturbing factor to the stability of the vessel. On the other hand, there is a tendency by

FIG. 1.—ADELINE SMITH, WITH CARGO OF LUMBER IN COOS BAY

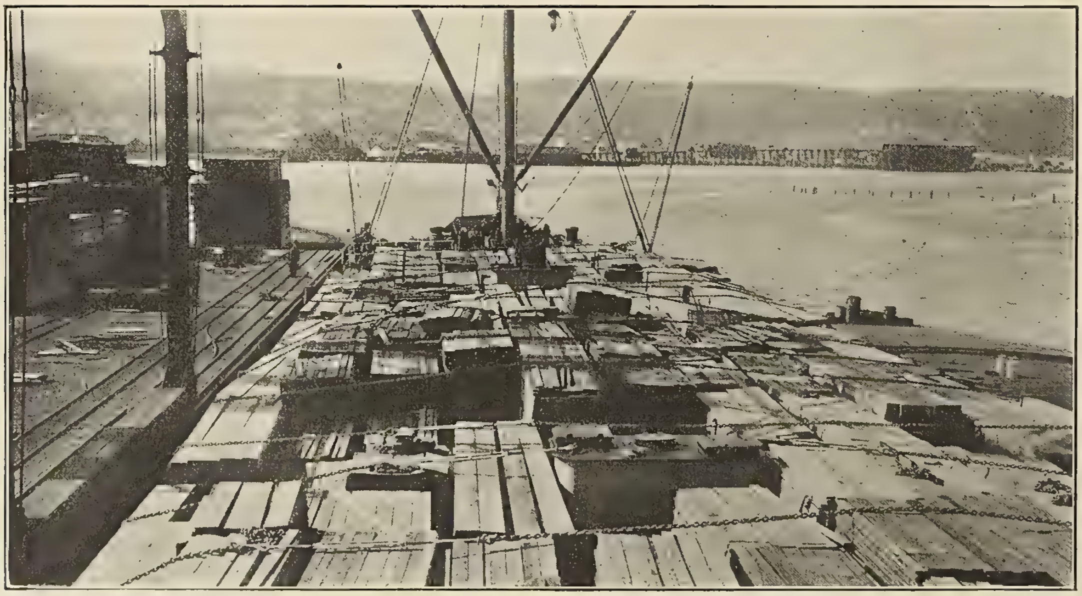

FIG. 2.—DECK OF ADELINE SMITH, SHOWING UNITS OF LUMBER OF CONSTANT WIDTHS, BUT OF VARYING LENGTHS AND SIZES

this arrangement to improve the stability on account of the fact that the center of gravity of the oil is lowered rapidly as the fuel is used from the tank. Other reasons of a practical character which contribute to the adoption of this design can be readily understood. The tank forms a substantial central bulkhead and longitudinal girder, thereby dispensing with hold pillars and compensating for the large holds necessitated by the size of the cargo units carried. Furthermore, as two of the cargo holds were to be used for deep-water ballast tanks, the fuel tank formed an excellent central bulkhead for this purpose.

Since going into service on the Pacific Coast, the *Adeline Smith* has established an excellent record for efficiency. The steamer made a fast run out from Newport News direct to Oregon, where her general cargo of railroad equipment and paper pulp machinery was delivered in a very satisfactory manner. From San Francisco to the mills in Oregon the voyage is generally against strong head winds and seas. As there is but little cargo offering for a Northern trip, a "light" ship makes very slow time against such weather. For this run, holds Nos. 3 and 4 in the *Adeline Smith* are filled nearly full with water ballast, and she proceeds steadily under the above conditions at excellent speed. The round trip between San Francisco and Coos Bay, Oregon, is made in four and one-half days, including loading and discharging. The distance one way is 410 nautical miles.

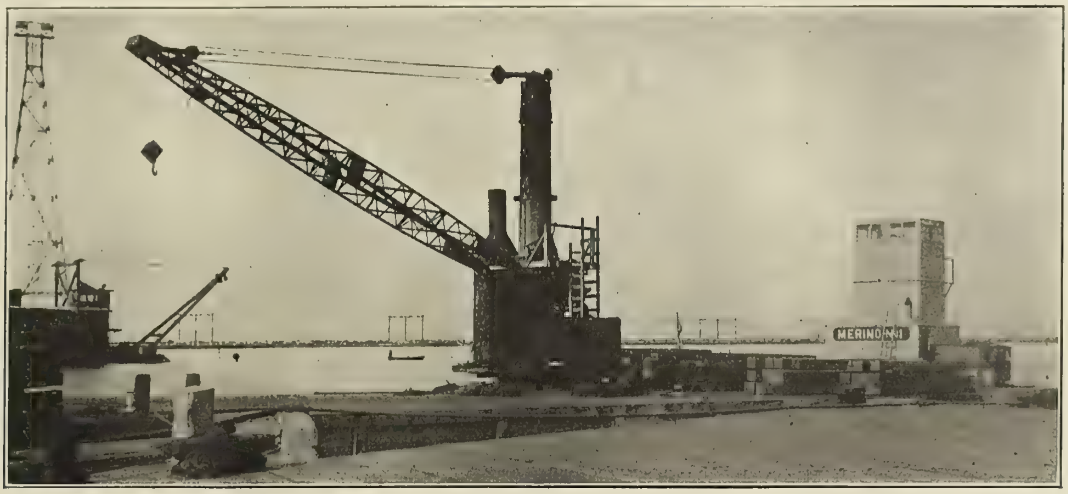

FIG. 3.—BARGE FITTED WITH STEAM REVOLVING CRANE FOR DISTRIBUTING LUMBER ABOUT THE BAY AND RIVER

In this ship it is beyond all probability that four holds can be opened to the sea simultaneously through any accident, but, should such an accident occur, the vessel would still float. The capacity of the bilge pumps is 1,100 tons per hour, the deep ballast tank pump then being capable of handling 1,000 tons per hour. In bad weather it has been noticed that against heavy seas the *Adeline Smith* is practically without the vibration which is ordinarily experienced in other vessels in the same trade not fitted with a central tank.

FIG. 4.—OVERHEAD ELECTRICALLY-DRIVEN YARD TRAVELER, WHICH UNLOADS THE VESSEL AND STORES THE LUMBER ABOUT THE YARD AS REQUIRED

The *Adeline Smith* is 310 feet 6 inches long over all, 44 feet 6 inches beam, molded, and 21 feet 6 inches molded depth, propelled by a 21, 35, 60 by 42-inch triple-expansion engine, supplied with steam by four Babcock & Wilcox watertube boilers buring oil fuel.

Single Screw Molasses Tank Steamer Amolco

The steamship *Amolco,* now under construction by the Fore River Shipbuilding Corporation, Quincy, Mass., for the Boston Molasses Co., is a single-screw steamer, with machinery aft, constructed of steel to the highest class in Lloyd's registry, being specially surveyed by that society to obtain the class 100-A-1, and designed to operate in either the molasses or bulk petroleum and general cargo and sugar trades.

The principal dimensions are as follows:

Length over all	325 feet 6 inches.
Length between perpendiculars	318 feet 6 inches.
Beam molded	46 feet 0 inches.
Depth molded to upper deck	25 feet 6 inches.
Depth molded to second deck	17 feet 6 inches.
Load draft	20 feet 0 inches.

General Arrangement

The vessel has a straight stem, semi-elliptical stern, two continuous steel decks and full poop, island bridge house amidships and topgallant forecastle. Accommodations are provided in the midship house for the officers with saloon, pantry, spare room and bath, and on the bridge deck above is the captain's suite, consisting of office and stateroom, having a wheelhouse and chart room over. The long poop encloses quarters for the engineers, oilers and petty officers, firemen and seamen, with a messroom for the officers and engineers, also bath and toilets.

The ship is rigged with two pole masts of steel, the foremast being fitted with four and the mainmast with two wooden derricks, each capable of hoisting a load of 3 tons.

The hold is divided into five double tanks, with a general cargo space forward and aft of same, the latter being separated from the former by cofferdams extending the full depth of the ship. The spaces on the second deck, at the sides and forward and aft of the expansion trunk, are also used for carrying general cargo, these and the holds being operated through large hatches fitted with wood covers and the usual tarpaulins and battening arrangements. The tanks are fitted with oil-tight hatches, and may be utilized for the transportation of molasses or bulk petroleum, a special pumping system having been installed for loading and discharging liquid cargo. A steam-heating system is also installed for liquefying cargo as well as for efficiently cleaning all spaces by steam.

The total capacity for stowing molasses is 800,000 gallons, and the capacity of the coal bunkers is about 500 tons. A double bottom is fitted under the coal bunker and machinery spaces and divided into two tanks, the one under coal bunker and boiler-room being used for reserve feed water and the one under engine-room for ballast.

The life-saving outfit consists of two 20-foot metallic life-boats and one 16-foot working boat, all boats being stowed on the poopdeck and handled by the usual round-bar davits.

Deck Machinery

The steering gear is of the Hyde combined hand and steam screw gear type, operated through shafting and bevel gears from steering stand in pilot house.

A self-contained Hyde steam windlass is fitted on the fore-castle deck, with warping ends on each side. Three Hyde steam-hoisting winches, 8¼ inches by 10 inches, double-cylinder double-drum are located on upper deck, each winch being reversible and designed for quick hoisting through double winch heads.

A quick-warping Hyde steam capstan is fitted on poopdeck aft and operated by horizontal engine on deck.

Pumping System

The pumping system for handling liquid cargo has been especially designed for pumping heavy viscous liquids, such as molasses or oil. The cargo pumps, two in number, are of the Blake horizontal duplex type, with steam cylinders, 16 inches in diameter, pump cylinders, 10 inches diameter, with 18-inch stroke. A 10-inch suction main of wrought iron extends through the cargo holds on the starboard side above the floors, with 8-inch suction branches extending into each tank, each branch being fitted with a steel gate valve and bell-mouth suction end. An 8-inch discharge main of wrought iron pipe extends through the holds above floor port side, with branches leading to each tank and to overboard discharge connections, forward and aft.

The entire system is so arranged that the cargo pumps can pump from the cargo tanks and discharge overboard from a barge direct to the cargo tanks, from any one cargo tank to any other, from the sea to any cargo tank for ballast purposes, and the tanks may also be filled through the discharge main.

Steam coils are fitted around the suction bell mouth in each hold, so that heavy oil cargo may be partially heated in order that it may run more readily to the pumps.

The forward ballast system consists of a 6-inch by 8-inch by 12-inch simplex steam pump in a pump room located in 'tween decks forward, with suction connections to sea, bilges, cofferdam and forepeak.

Electric Plant

The electric lighting plant consists of a one-kilowatt General Electric marine generating set, with switchboard and necessary wiring and fixtures.

Propelling Machinery

The propelling machinery, located in the stern of the ship, consists of a vertical inverted, three-cylinder, triple-expansion engine, with cylinders 22—37—60 inches diameter, having a stroke of 42 inches, supplied with steam at 180 pounds pressure by two single-ended Scotch boilers working under a heated forced draft system.

The bedplate of the main engine is of the usual box-section type of cast iron in three sections, having six main bearings of cast iron lined with white metal. The bearing caps are of cast iron lined with white metal. The cylinders are supported by six cast iron columns of box section, three front and three back. All crosshead guides are fitted for water circulation. The crankshaft is of the built-up type, of forged steel throughout, in three interchangeable reversible sections.

The cylinders are arranged beginning at the forward end of the engine, high pressure, intermediate pressure and low pressure. The pistons are of cast iron, box section, fitted with followers and piston rings. The high-pressure cylinder is fitted with a liner, the valve being of the piston type, the intermediate valve is of the piston type and 14 inches in diameter, and the low-pressure valve of the double-ported slide valve type. The valve gear is of the usual Stephenson double-bar link gear type.

The reversing gear consists of a direct-acting steam cylinder, 9 inches diameter and 18 inches stroke, secured to the back of the intermediate pressure back column.

A 7-inch by 5-inch single cylinder reversible turning engine is fitted at the after end of the main engine bedplate.

The thrust bearing is of the usual horseshoe type, having seven adjustable cast iron horseshoes faced with white metal. Each shoe may be adjusted separately, while the entire bearing may be moved fore and aft by means of wedges.

The propeller is of the built-up type, 15 feet 6 inches diameter, 16 feet 3 inches pitch, 72.6 square feet developed area,

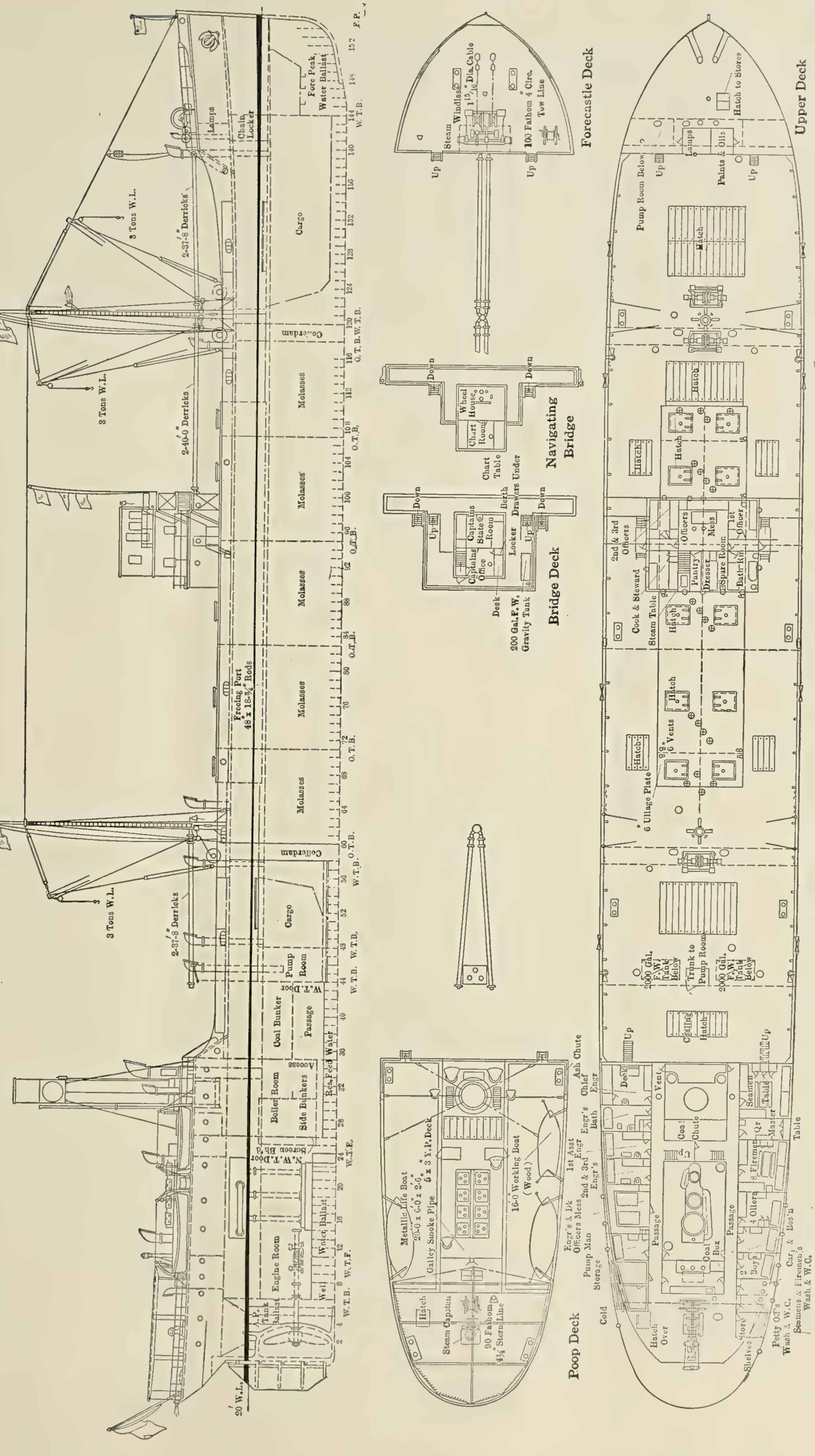

FIG. 1.—GENERAL ARRANGEMENT OF MOLASSES STEAMSHIP AMOLCO

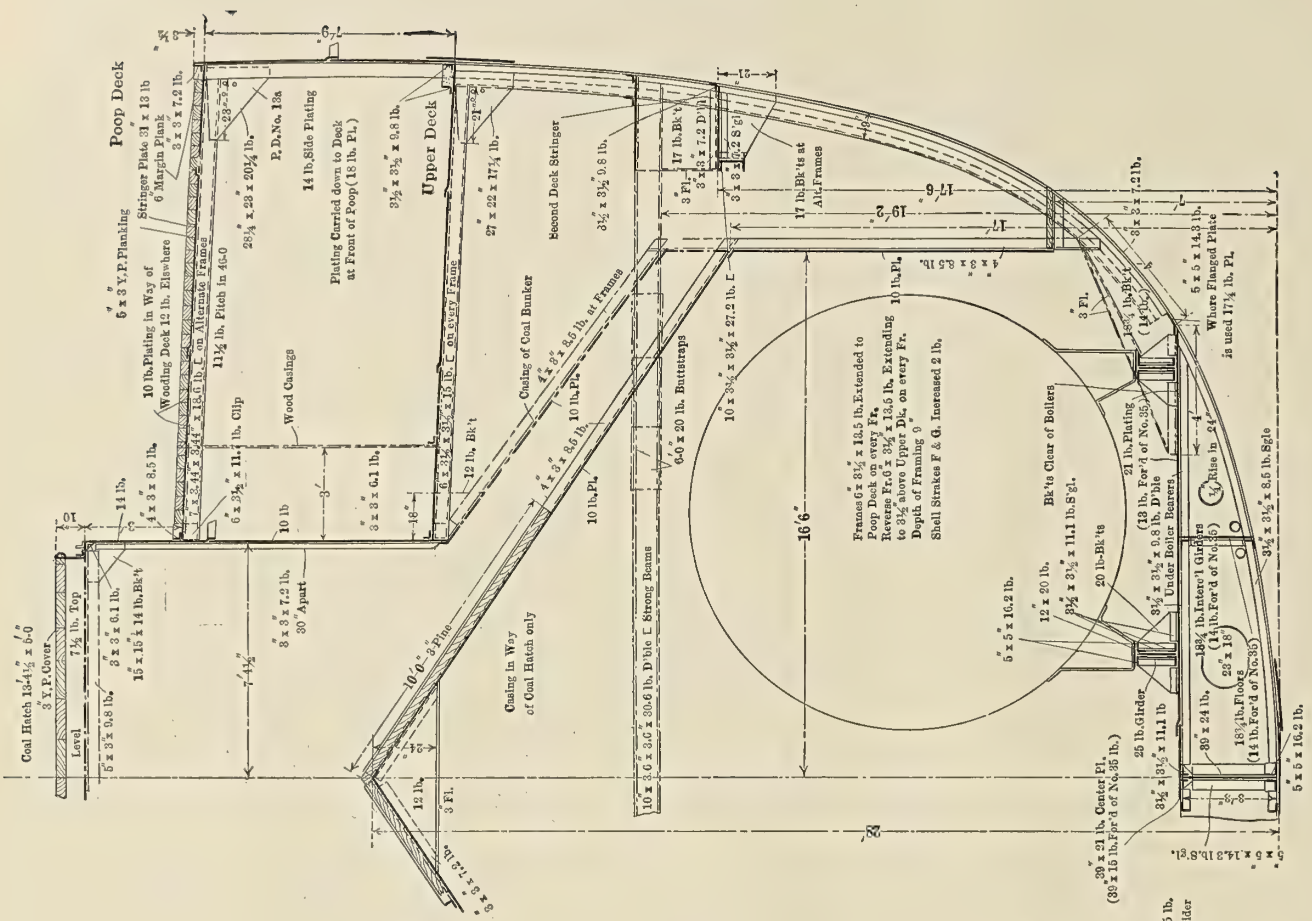

FIG. 3.—SECTION IN WAY OF BOILER SPACE

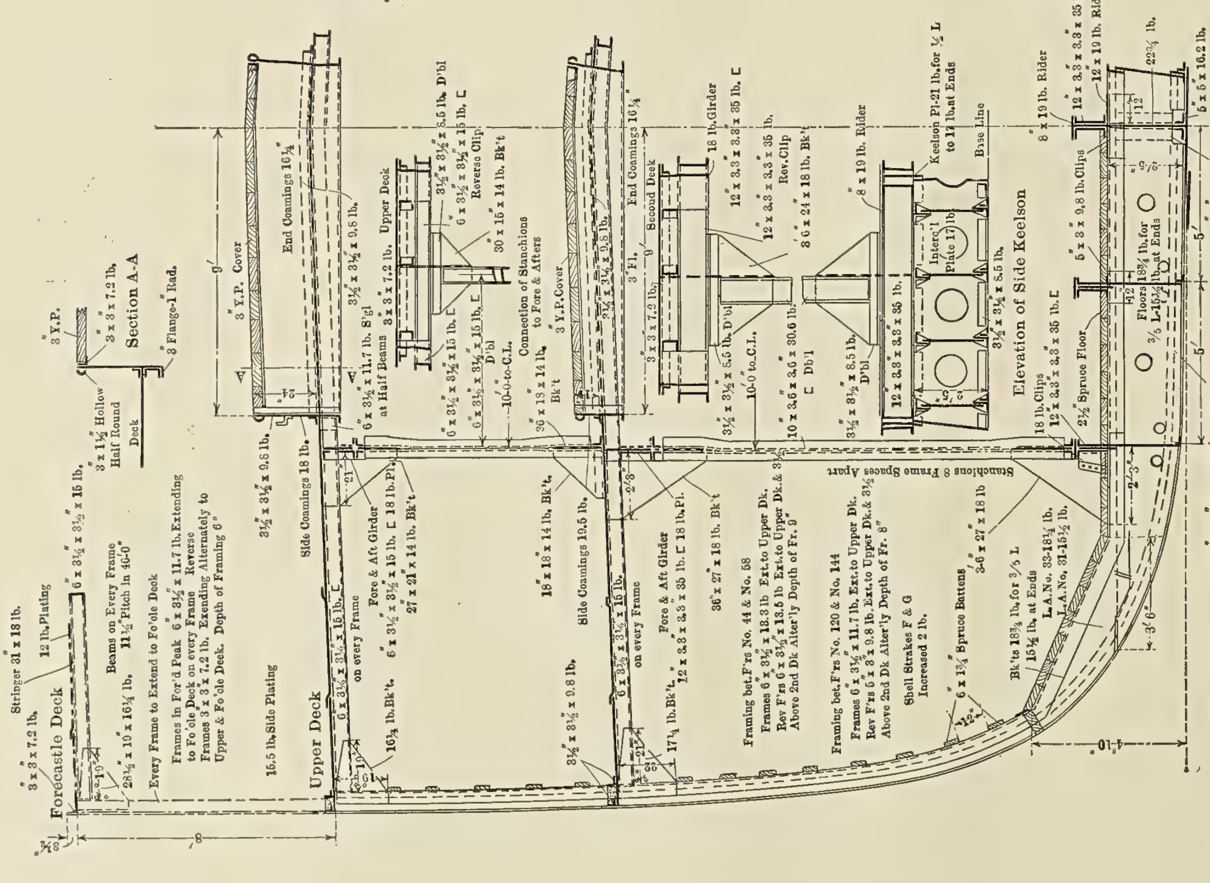

FIG. 2.—SECTION IN WAY OF FOR'D CARGO HOLD (AFTER CARGO HOLD SIMILAR EXCEPT AS SHOWN)

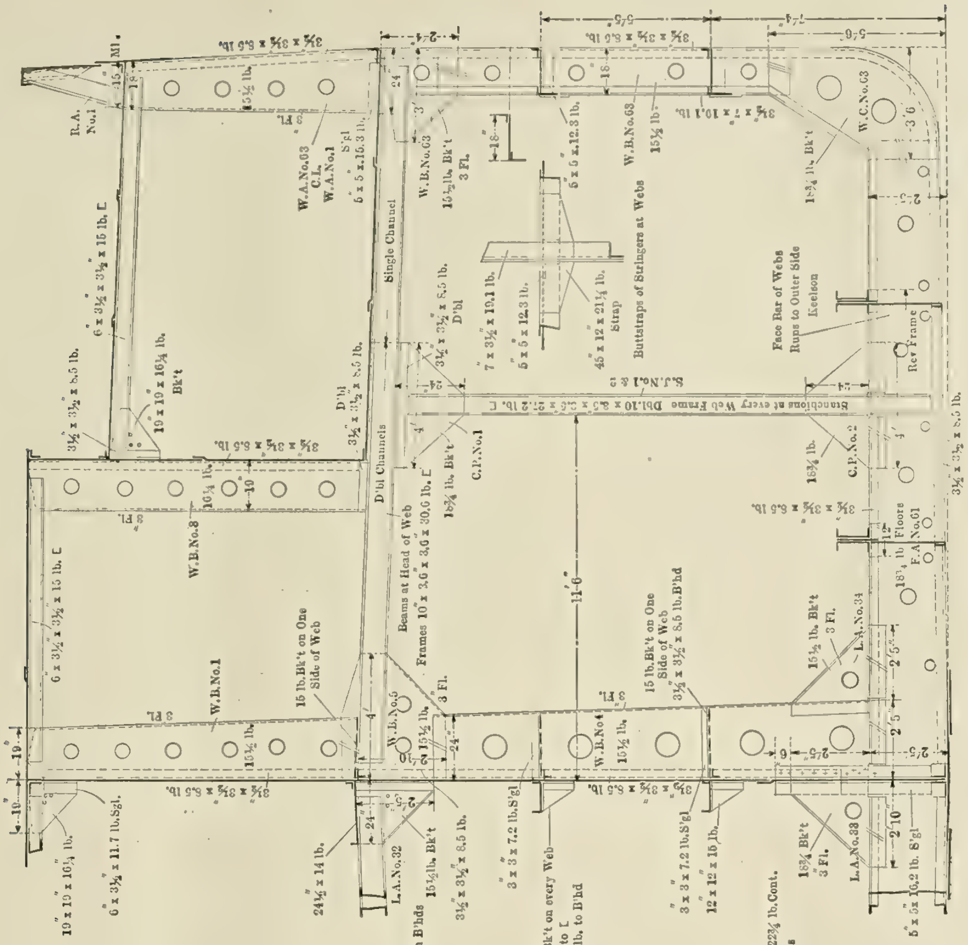

FIG. 5.—SECTION IN WAY OF WEB FRAMING IN MOLASSES TANKS, LOOKING FORWARD

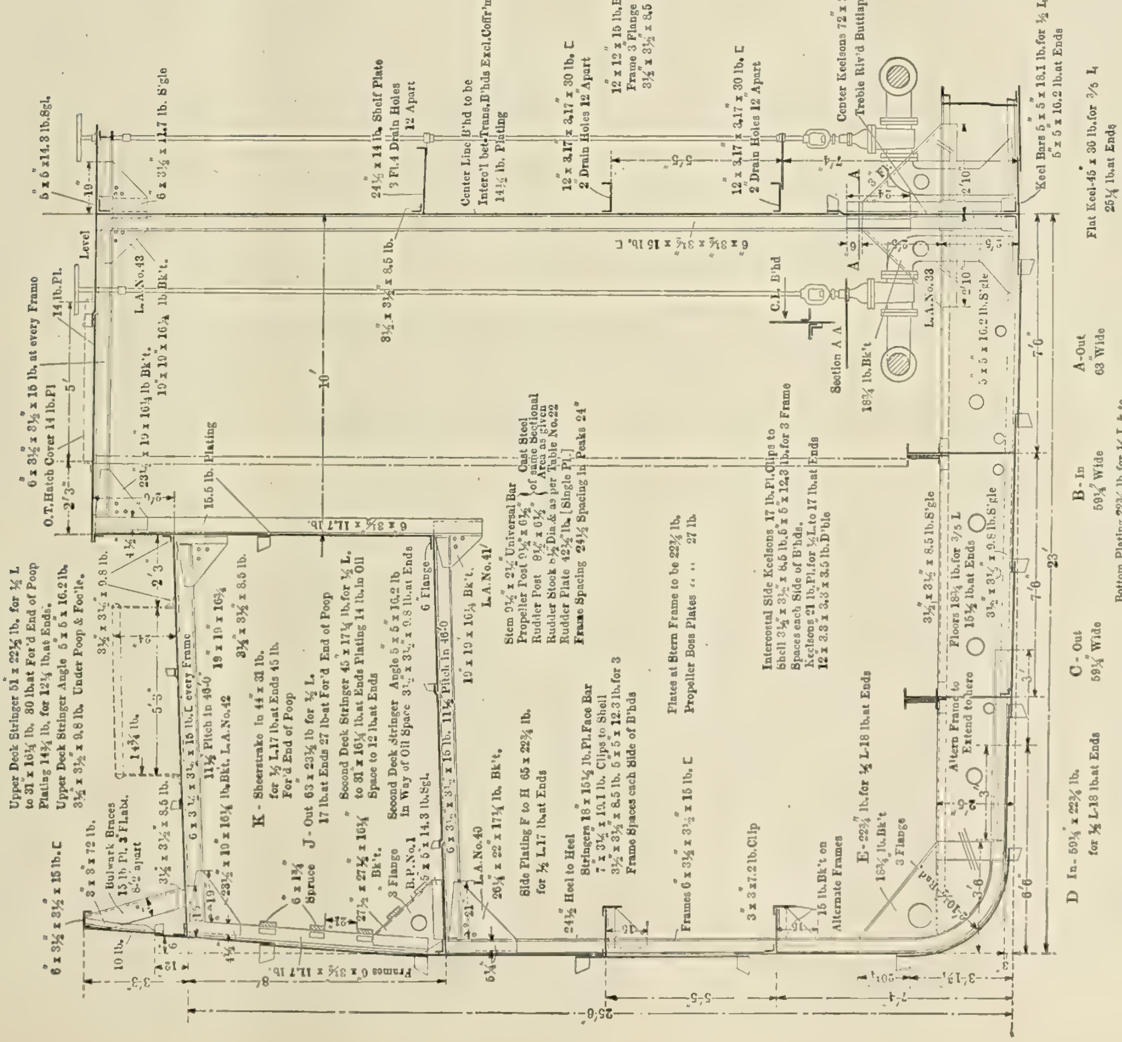

FIG. 4.—SECTION IN WAY OF ORDINARY FRAMING IN MOLASSES TANKS, LOOKING AFT

having four adjustable cast steel blades secured to a cast iron hub by bronze studs and nuts.

Boilers

The boilers are 13 feet 6 inches mean diameter and 10 feet 10 inches long, arranged in a single fireroom. Each boiler has three Morison furnaces, 42 inches inside diameter, and three combustion chambers. The tubes are 2½ inches outside diameter. The total heating surface for the two boilers is 4,000 square feet, with 100 square feet of grate, giving a ratio of 40 to 1.

Air for the heated forced draft is delivered to the furnaces by a fan located in the fireroom and driven by a 6-inch by 5-inch vertical engine. On each uptake there is a heater box around which the air passes before entering the furnaces.

The vessel is fitted with one circular stack, single above the deckhouse, double below, 5 feet 6 inches outside diameter, about 70 feet high above the grates.

Auxiliaries

The air pump is of the Edwards type, 20 inches diameter, 19-inch stroke, driven by beams and links from the low-pressure crosshead.

The condenser, placed on brackets at the back of the engine, has a cooling surface of 1,800 square feet. Circulating water is taken from a centrifugal pump of the Fore River type, having 12-inch suction and discharge, the pump being driven by an 8-inch by 8-inch vertical engine.

The following additional pumps are fitted:

Two feed 3½-inch by 19-inch stroke, plunger type, attached to the low-pressure crosshead, with suctions from the sea; after tank, auxiliary condenser, feed tank and boilers, and discharge through the feed-water heater or direct to the boiler through the main or auxiliary feed line, or overboard; one auxiliary feed pump, 7½ inches by 4½ inches by 10 inches, Blake vertical duplex, 3 inches suction, 2½-inch discharge. One ballast pump, 10 inches by 12 inches by 10 inches, Blake horizontal duplex, 7-inch suction, 6-inch discharge. One salt water sanitary pump, 6 inches by 4 inches by 6 inches, Blake horizontal duplex, 3 inches suction, 3 inches discharge. One fresh water pump, plunger type, attached to main engines, 1¾ inches diameter, 8 inches stroke, 1-inch suction, 1-inch discharge. One evaporator feed pump, plunger type, attached to main engine, 1¾ inches diameter, 8 inches stroke, 1-inch suction, 1-inch discharge.

An auxiliary condenser, containing 400 square feet of cooling surface, is located in the engine-room; circulating water is taken from the ballast pump. One evaporator of the Griscom Russell type of 10 tons' capacity is located in the engine-room, steam being taken from the auxiliary steam line and vapor discharged to the condenser or feed tank.

The refrigerating plant consists of a one-ton ammonia direct-expansion type outfit, motor driven. One ash hoist engine of the Hyde make, 4½ inches by 4½ inches double cylinder, is located in the fireroom.

The Steamship Westerdyk

The *Westerdyk,* which recently underwent her official trials, is the second of two very fine vessels built by Messrs. Irvines' Shipbuilding & Dry Docks Company, Ltd., for the Holland-America Line, of Rotterdam. The dimensions are 470 feet by 55 feet by 41 feet 7½ inches depth, molded, to the shelter deck, and complete main, upper and shelter decks are fitted with a tier of strong beams at the lower deck height, and steel grain divisions all fore and aft. She is built to Lloyd's highest class, having bulb angle frames and a cellular double bottom all fore and aft for water ballast, together with a deep tank at each end of the engine and boiler space.

The vessel is fitted with four masts of sufficient length for the carrying of the aerial wires in connection with a Marconi installation, and a most complete and up-to-date arrangement of loading and discharging gear is provided, consisting of twenty 7-inch by 12-inch silent-running steam winches, together with eight derrick posts and thirty-two Mannesmann steel derricks; in addition to this a 40-ton steel derrick is fitted so as to deal with heavy lifts in either No. 1 or No. 2 hold, a special worm gear winch being provided for working this derrick.

A special feature of this vessel is that the whole of the accommodation, including the sailors' and firemen's, is placed in a large steel house on the shelter deck amidships, having a promenade deck over same 150 feet in length. The sailors and firemen are berthed in separate compartments, with large messroom, wash places, lavatories, etc., for each department. Accommodation generally for the captain, officers and engineers is fitted in spacious rooms, special attention having been paid to light and ventilation; steam heating is also fitted throughout the whole of the accommodation. A special Marconi room is situated on the shelter deck amidships, complete with silent chamber, etc., and a long-distance wireless telegraphy installation has been fitted by the Marconi Company.

The machinery, which has been constructed by Messrs. Richardsons, Westgarth & Company, Ltd., Hartlepool, consists of a powerful set of balanced quadruple-expansion engines, with six large boilers working under natural draft at a pressure of 215 pounds per square inch. The cylinders are 27½ inches, 37¾ inches, 55 inches and 84 inches diameter by 60 inches stroke, each being independent, with receiver pipes of steel and universal expansion glands. The high-pressure cylinder is fitted with a piston valve, the two intermediate cylinders with flat balanced valves and the low-pressure with a double-ported slide valve, the ports and passages being in accordance with the engine builders' latest practice. Each of the cylinders is supported by two heavy cast iron columns, which are braced together at the top with strong box girders, these also forming supports for the reversing gear. The shafting throughout is of fluid compressed steel, the crankshaft being in four interchangeable parts with webs of special form as required for the system of balancing; the large four-bladed propeller is made entirely of bronze.

The condensing and feed heating installation is very complete, and embraces the entire contraflo system, as adopted when independent feed pumps are fitted in addition to the feed pumps on the main engines. The system comprises contraflo main and auxiliary condensers, direct-contact oil separating feed heater, Cascade water filter and thermal receiver and drainage separator, the independent feed pumps being of the Mumford "Dreadnought" type. An excellent arrangement has been effected in the engine room of the large number of auxiliaries; these, in addition to those forming part of the contraflo system, include Drysdale centrifugal pump, Mumford auxiliary feed pump float controlled from Cascade filter, Mumford's ballast and general service pumps, and combined air and circulating pumps for the auxiliary condenser, also a Morison's surface feed heater and a large evaporator of the vertical radial type.

Award of Howard N. Potts' Gold Medal.—Professor Wm. A. Bone, D. Sc., Ph. D., F. R. S., Professor of Chemical Technology of the Imperial College of Science and Technology, inventor of the Bonecourt system of flameless incandescent surface combustion, and technical adviser to Bonecourt Surface Combustion, Ltd., has been awarded by the Franklin Institute of Philadelphia its "Howard N. Potts' Gold Medal for distinguished work in Science or the Mechanic Arts," in recognition of his work on "Surface Combustion," upon which subject he gave a lecture before the institute on October 30, 1911.

First Dutch Shipping Exhibition

BY F. MULLER VAN BRAKEL

The first Dutch shipping exhibition was opened June 4 at Amsterdam. The exhibition grounds are located where the visitors are afforded a splendid view of the picturesque city of Amsterdam and of the shipping activities of its famous harbor. The building devoted to Amsterdam, which contains pictures and models showing the advance of commerce, and the building housing the historical section of the exhibition, are situated in a beautiful garden, while the main buildings, including the British section and the places of entertainment, are situated behind the garden.

As it would be impossible to describe or even mention, in the limited space available for this article, all of the separate exhibits, only those of most importance and deserving special mention are recorded in the following:

The Nederlandsche Scheepsbouw Maatschappij, of Amsterdam, has a large exhibit, with fine models, of its latest ships, including the India liner, *Koningin der Nederlander,* of 8,200 tons and 15 knots; the Belgian Diesel motor-tank ship, *Emanuel Nobel;* and the well-known *Vulcanus.* A half model is also exhibited of the *Emanuel Nobel,* showing the internal arrangement of the big oil tanker, with its bulkheads and cofferdams, piping arrangement and the two Werkspoor Diesel engines of 1,100 brake horsepower each.

In the exhibit of the Maatschappij voor Scheeps-en Werktingbouw Fijenoord, Rotterdam, is a model of the first marine compound engine, which was built in its shops. Models of the cylinders of marine engines in this exhibit show a very ingenious arrangement of flat high-pressure valves, with a relief hood between the high-pressure and intermediate-pressure cylinders, leaving the working face of the valve quite accessible and open for inspection and regrinding, and, at the same time, shortening the length of the engine some 4 feet.

A model of the latest 30-knot destroyer, built for the Dutch navy, is exhibited by Kononklijke Maatschappij de Schelde, Flushing. Werf Gusto, of Schiedam, exhibits the model of a 150-ton floating crane built for the Italian navy, and an interesting model of a gold dredger is exhibited by Werf Conrad, Haarlem.

The Koninklijke Paketvaart Maatschappij, whose fleet of 85 modern steamers connects the islands of the Dutch East India archipelago with Australia, is represented by a large plastic map showing the routes and steamers of the company.

On a small stand, by means of a couple of models, is shown a novel method of arranging lifeboats on liners, by which three boats may be stowed on the outer edge of the boat deck, where commonly only one boat can be placed. This is accomplished by attaching each boat under one stout Welin davit, both being placed in a vertical position. The bow of the boat then points upwards, the sternpost extending transversely parallel to the deck. By swinging over the davit, the boat is brought into a horizontal position, with the bow away from the ship, and it may then be lowered in the ordinary way. On reaching the water the boat is well clear of the vessel and in no danger of being crushed against it. Patents have been taken out for this arrangement by the inventor, Mr. Lagaay, an officer of the Holland-America Line.

Among the models of British-built Dutch ships, two may be mentioned:

The *Gelria,* of 14,500 tons gross and 11,500 indicated horsepower, building at Messrs. Alex. Stephen & Sons to the order of the Hollandsche Lloyd (Amsterdam-Buenos Ayres), and the *Nestor,* of the Dutch Blue Funnel Line. The latter is one of the very few models of cargo boats, and is equipped with 22 cargo winches, 4 masts and many derrick posts, showing a most up-to-date loading and discharging arrangement, which will attract the attention of masters, stevedores and shipowners.

The same class of people will be attracted by another stand, outside the main building, where the newest type of Sieurin's cargo winch may be seen handling cargo. The usual modern loading or discharging gear consists of two steam winches in combination with two derricks. The load is raised by one winch, then swung to the side by the other and lowered by the two winches paying out at the same time. The Sieurin winch, on the other hand, is fitted with two independent drums worked by the same set of cylinders, and it is thus possible to perform all necessary operations by means of one Sieurin winch. Besides the usual stop valve, reversing lever and foot brake, the Sieurin winch has only one extra lever and can be worked by one man, without special training.

A part of the main exhibition is devoted to statistical and other information concerning the Dutch merchant fleet, the different types of sailing vessels, the location of shipyards in Holland, etc. On a large table (70 feet by 17 feet), representing the North Sea, are placed some five hundred models (built on a scale of 1:500), representing the complete fleet of Dutch steamers.

Though the exhibition is a national one, there is a British section, where most of the best-known British shipbuilders and marine engineers have fine exhibits. Among these may be mentioned: Armstrong, Whitworth & Company, Ltd., with splendid models of warships, including the Brazilian dreadnought *Rio de Janeiro;* Vickers Sons, exhibiting ships and guns; John Brown & Company, Ltd., with models of the *Hindustan, Asaki, Inflexible* and others; Hingley & Sons, with cable links; Welin Davit Company, Ltd.; Parsons Marine Steam Turbine Company, Ltd.; and William Hamilton & Company, Ltd., exhibiting models of well-known Dutch freighters.

This section gives a splendid opportunity to study the development of British-built dreadnoughts, and it is interesting to note that again the lead is given to foreign-owned Elswick ships. It is to be regretted that no catalogue of the British section has appeared.

Illumination of Docks and Wharves

The vast sums of money invested in modern vessels make it imperative that every facility be provided for their speedy loading and unloading, as the earning power of a vessel is naturally suspended while it is docked.

For years inventors have worked on machines and methods of speedily accomplishing this end, and with wonderful results, but it is only within a comparatively short time that there has been a realization of the importance of proper illumination in this connection.

The same conditon also obtained in industrial plants until recently, when illuminating and efficiency engineers compiled statistics that showed startling results. For instance, it was shown that a substitution of proper lighting for poor lighting increased the efficiency of the workmen in some plants 10 percent; and a few isolated cases were found where the efficiency, or output, during the time artificial light was used, was increased as much as 25 percent. Furthermore, it was proven conclusively that the number of avoidable accidents was in direct proportion to diminishing light; and it is claimed by authorities who have made a study of safeguards for the benefit of employees that 25 percent of the avoidable accidents were caused by poor illumination.

That which holds true regarding the increased efficiency resulting from the proper lighting of industrial plants also holds good for docks and piers, and possibly to a greater extent. The proper illumination of docks and piers not only materially increases the efficiency of the workmen by enabling them to read the markings on freight with facility, lighting their way distinctly, etc., but it greatly decreases the liability to accidents. This is a very important item, as the nature of the work which stevedores and freight handlers do is very hazardous.

FIG. 1.—ILLUMINATION OF QUEBEC STEAMSHIP COMPANY'S PIER, NORTH RIVER, NEW YORK

When the dock is a passenger terminal, proper lighting is of extreme importance from another point of view, as it has an important psychological bearing on the impression given the arriving or departing passenger regarding the service of the line; in other words, plenty of light tends towards cheerfulness. That this feature is important is demonstrated by the modern tendency of railroads to illuminate brilliantly their waiting rooms.

FIG. 2.—EXTERIOR OF TYPE W LAMP

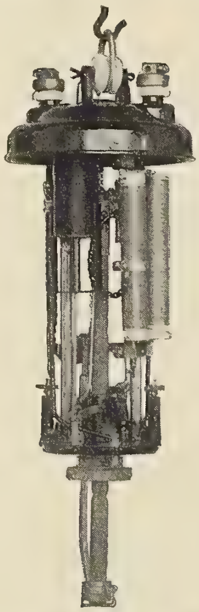

FIG. 3.—MECHANISM OF LAMP

A recent example of good pier illumination is at the Quebec Steamship Company's pier, North River, New York City. This pier is 400 feet long by 60 feet wide, and is so arranged that boats may be unloaded from either side. Four Type-W long-life multiple flame arc lamps, manufactured by the General Electric Company, have been installed. These lamps are located along the longitudinal center of the building, and are approximately 24 feet above the floor. As soon as it becomes dark the two end lights are turned on and are kept burning all night. When shipments, however, are being unloaded the remaining two lamps are also lighted.

The Type W lamps are especially adapted for this class of lighting, because they are an exceptionally high candlepower unit, and the brilliancy remains undiminished throughout the carbon life. They are very economical to operate, as they burn from 100 to 120 hours without attention, and even then it is necessary to renew only one electrode. The mechanism is extremely simple, and the parts are especially treated so that dampness and salt air can have no effect.

Steel Tug Senator Bailey.—John H. Dialogue & Son, Camden, N. J., has recently completed for the Steele Towing & Wrecking Company, Galveston and Texas City, Texas, the steel tug *Senator Bailey,* 125 feet long, 26 feet 6 inches beam, 14 feet depth of hold, designed by T. J. Anderson. Propulsion is by compound engines, supplied with steam at a pressure of 150 pounds per square inch by a Scotch marine boiler, fitted with oil fuel burners of the Dahl type. The fuel tanks have a capacity of 56,000 gallons, which will enable the tug to steam for about twenty days without replenishing her fuel supply. The auxiliaries include a 10 horsepower donkey boiler, feed water heaters and filters, and a 7½ kilowatt dynamo which supplies current for lighting and for a powerful wireless equipment. The tug is thoroughly fitted out for towing, salvage, wrecking and fire-fighting purposes.

The Spokane, Portland & Seattle Railway Company's New Steamships.—The two passenger steamships building at William Cramp & Sons' Ship & Engine Building Company, Philadelphia, for the Spokane, Portland & Seattle Railway Company, are 500 feet long, 63 feet beam, 34 feet 6 inches molded depth. They are to be propelled by Parsons turbines at a normal speed of 22 knots and will be used in Pacific coastwise trade, although terminals have not been announced.

Ship Construction Treated from a Structural Engineering Standpoint

BY JAMES E. STEELE, B. Sc., A.M.I.N.A.

The material of which a vessel is composed does not appear, as a general rule, to be disposed in such a manner that the strength at any point of the vessel's structure is proportional in all cases to the stress at that point. Were the question of the strength of the vessel treated just as minutely and with as careful a regard to the relation of the strength of the member to the stress it is called upon to bear, as in a structural engineering problem, a better result would in all probability be obtained for the same weight of material. A saving of weight in one part would mean material in hand which could be used freely in strengthening parts which are greatly stressed, due to local weights, discontinuities in structural strength, etc.

If it is agreed that the general run of vessels are sufficiently strong at all points, then the following may indicate where weight could be saved without, of course, sacrificing strength. Before altering the arrangement of material, however, either for a better result as regards strength, or as a means of weight saving and consequent reduction in cost of material and increase in earning capacity, we must consider the increased cost, if any, of workmanship and maintenance.

The object of this article is to urge the engineering method of treating each structure, or vessel, as a new problem, and each item on its own merits. It is thought that the best way of illustrating the treatment suggested is by treating one portion of the vessel, and a choice has been made of the cellular double bottom, with a view to obtaining a structure of adequate strength, and yet effecting a saving in weight over present-day practice.

The problem, a solution of which is sought here, is to get a bridgelike structure which will carry the uniform load due to cargo, etc. What follows refers to a transversely built vessel; to read it into the longitudinal system, the simple interchange of the terms "floor" and "longitudinal" is alone required.

Load on Floor

The load is composed of a uniformly distributed load, due to weight of cargo, weight of structure, etc., and concentrated loads due to pillars, the heads of which are loaded, and to the longitudinals. Two extreme cases of maximum loading are taken below:

Case I. Uniformly Distributed Load; Double Bottom empty.—The weight of the cargo is such as will sink the vessel to the load-line. To arrive at the proportion which the floor bears of the total cargo load per floor space, we proceed as follows: The plate, if loaded to destruction, fails by cracking along the dotted lines (Fig. 1), approximately, so that we take the load on the hexagon *A* as being borne by the floor, and that on the square *B* as being borne by the longitudinals.

The weight of the structure comprises the floor, the portions such as *A* (Fig. 1) of the inner bottom and shell, which though not uniformly distributed along the floor, may be taken as being so.

Uniformly distributed load = weight of cargo + weight of structure — vertical component of water pressure over parts such as *A*, Fig. 1.

These are distributed as under:

Top Boom, or top member:

Uniformly distributed load = weight of cargo + ½ weight of floor + weight of inner bottom.

Bottom Boom, or bottom member:

Uniformly distributed load = ½ weight of floor + weight of shell — buoyancy.

Case II. Uniformly Distributed Load; Double Bottom full and pressed.—The weight of the cargo (*W*), assumed to be wood carried in holds and on deck, is such that, when added to the weight of the water (*w*) in the tanks—required for stability—it sinks the vessel to the load-line:

Uniformly distributed load = weight of cargo + weight of structure + weight of water in tank — vertical component of water pressure.

The pressing of the double bottom does not enter into the equation, as the double bottom is a self-contained system, and any forces set up within that system cannot affect the external forces acting. It is a different matter, however, when we consider the load applied to each boom, which is important, from the point of view of the stresses in the web.

These are distributed as follows:

Top Boom:

Uniformly distributed load = weight of cargo $W - w$ + ½ weight of floor + weight of inner bottom — pressure of water in tank.

Bottom Boom:

Uniformly distributed load = weight of water in tank, w + ½ weight of floor + weight of shell + pressure of water in tank — buoyancy.

It will be seen that the uniform load on the upper boom is less, and that on the lower boom is more in *Case II.* than in

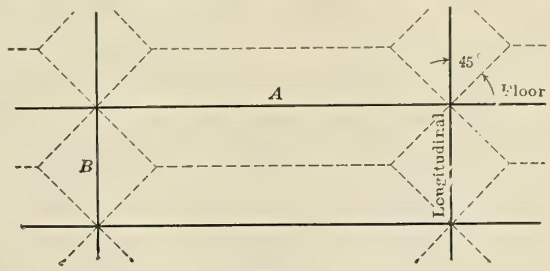

FIG. 1

Case I. Both cases must, therefore, be worked out, and each member designed to meet the greater of the two stresses obtained.

Another case which may have to be treated is that of the vessel in ballast. In this case the uniformly distributed load on the top boom is half the weight of the floor, plus the weight of the inner bottom, and minus the pressure of water in the tank. The uniformly distributed load on the bottom boom is the weight of water in the double bottom, plus half the weight of the floor, plus the weight of the shell, plus the pressure of the water in the tank, and minus the upward pressure due to buoyancy. In this case the lower boom is in compression and the upper in tension.

The relative importance of these three cases cannot be discussed generally, but with figures at hand for the weights mentioned in the three cases a few minutes will show which cases are extreme and therefore worthy of consideration.

Concentrated Loads

Some of the loads are applied by the pillars, and in as many places as there are rows of pillars. The beam which the pillars support is in the position of a beam with built-in ends, supported by one or more pillars, and loaded with a uniform load, due to the weight of the beam, deck and deck cargo, if any. Local weights, such as winches, etc., may also have to be borne.

The remaining concentrated loads are those applied by the longitudinals.

Support to the Floors

The sides of the vessel offer the support to the ends of the floor. In reality, the sides sling the bottom under nearly all conditions, and this has the same effect as the support offered by abutments to a beam.

The strength required, from this point of view, for connection to the frame outside the tank, is sufficient shearing strength to prevent the bottom from tearing out the vessel, or, in the case of a "light" vessel, of being forced into her. In addition, however, the strength of this connection must be sufficient to "fix" the end of the frame so that it may act as a beam built in at the ends. The connection outside the tank is much greater, for the latter reason, than is required to withstand the shear mentioned above, so that we do not need to further consider the strength against shear. We will treat the floor as being simply supported at its ends.

Type of Floor

A form of floor equivalent to the open-web type of bridge girder is adopted in preference to the plate-web type for several reasons.

The braced girder is more economical of material than the plate-web girder, as we can grade the strength of the former so as to get a girder of uniform strength, *i. e.*, one whose strength at any point is proportional to the stress at that point.

Drawing the shearing force and bending moment diagrams for a beam uniformly loaded, and simply supported at its ends (Fig. 2), we see that the shearing force is greatest at the ends

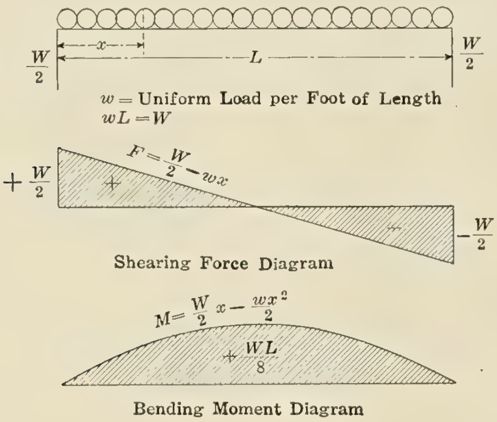

FIG. 2

and least at the middle, and that the converse holds for the bending moment. The addition of concentrated loads would not alter these characteristics, though it would affect the values of the shearing force and bending moment at different points along the length of the beam.

The above shows the variation in stress along the length of the floor, and as the booms take the whole of the bending moment, and the web the whole or the greater part of the shear, we see that there is no call for uniform strength throughout the length of the girder, which we get, practically, in the floor as usually fitted.

In a plate-web floor, we could grade the booms to meet the varying bending moment, but the web must be thick enough to meet the greatest stress, so that material is wasted throughout a great part of its length. This grading of web strength is very easily accomplished in a braced girder.

In the floor as fitted, it may be urged that the angles for attaching it to the longitudinals stiffen it against buckling, but if the plate be economically thin, any angle stiffening should be spaced more closely together as the ends of the floor are approached. Again, these stiffeners are not at an efficient angle, the efficient angle being 45 degrees towards the supports, as can be seen from the following:

Shear in a vertical plane is accompanied by a shear stress of equal intensity in a horizontal plane (Fig. 3). These produce two direct stresses of equal intensity, as shown, also at right angles to one another, but inclined at 45 degrees to the shear stresses. The plate will tend to buckle under the action of the compressive stress, although the buckling is prevented to an extent by the tension at right angles to it tending to hold the metal in its true plane. The stiffener fitted to prevent this buckling—the only way in which the plate is likely to fail—should, therefore, incline towards the support at an angle of 45 degrees.

In adopting the braced floor, we have the satisfaction of knowing that the very best has been got out of the material used, and that no material is thrown away in places where it is worse than useless.

The actual saving in weight of the open-web floor over the plate-web floor is a cumulative one, as a saving of weight in any member means a lighter structure, and this, again, results in a saving of weight in every other member, as a smaller structural weight has to be carried. Even a small saving of weight in each floor is worth while, as when multiplied by the number of floors where the reduction can be made the saving is appreciable.

The open web gives ready access to all parts of the double bottom without sacrifice of strength. The same cannot be said for the manholes which are cut out of the plate web just where its strength is most required, *i. e.*, where the shear is greatest, the curve of shear stress in the direction of the depth of the floor being parabolic.

Another advantage in the open-web floor is that, for the same span, an increase in the depth of the floor means a saving in weight. As the stresses, and, consequently, the cross-sectional areas of the booms, vary inversely as the depth of the floor, an increase in the depth will mean a saving in boom

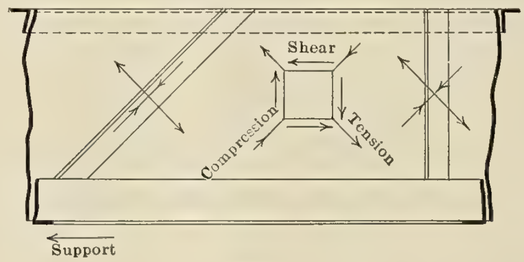

FIG. 3

weight, which more than compensates for the additional weight of the diagonal members, which are longer than before, though their scantlings remain the same, the shearing force being unaltered.

In an open-web floor, moreover, there is a saving over the plate-web floor of surface of metal exposed to corrosion.

For docking, a strong longitudinal fitted in the middle line would support that portion of the weight of decks, etc., which is taken by the pillars, that is, supposing a central row of pillars. The rest of the weight of the vessel (the double bottom excepted) is supported by the floor acting as a double cantilever, the forces at the bilges zigzagging through the bracing to the blocks. When quarter pillars are fitted, the bending moment on the double cantilever is greater than with the central row of pillars. If there is any doubt as to the capabilities of the open-web floor for supporting the vessel when docking, a reciprocal diagram can easily be run out for the central support, and the stresses determined.

Exception may be taken to the fact that there is not a sufficient margin of strength in the open-web floor against grounding, if such were to happen; but there is no reason why an open-web floor should not resist such crushing equally as well as a plate-web floor. It might be argued that even if the open web adopted were to crush on the vessel taking the ground, it would be preferable to the floor resisting buckling, but starting the rivets in the inner bottom plating. In any case, the proposed open-web system, when fitted on every frame, will give as much support to the shell as the solid floor fitted on every second frame, alternating with a very meagerly supported frame and reverse.

Arrangement of Bracing

The simplest form of bracing we can adopt is one which will result in a floor built up of triangles, and therefore rigid. In this type, when we assume pin-joints, the members are subjected to pure push and pull, and the values of the stresses can be exactly determined by means of the reciprocal diagram, or by the method of sections. It will, however, probably be found that a more complicated form of bracing is desirable, so as to better distribute the boom support, also to provide for unequal loading of the floor. The fewer the systems we combine to form the floor the better the size of the diagonal members would be reduced in all cases as we approach the center where the shearing force is least; but when the member is small to start with, the practical minimum of size (mainly fixed by corrosion considerations) is reached before we attain the least stressed diagonal. In this way diagonals have to be fitted which are uneconomical, being heavier than the stresses require.

The form shown (Fig. 4) has many advantages. It is composed of two simple systems superposed. In arranging the bracing, it should be borne in mind that 45 degrees is the most efficient inclination of the diagonal members. Floors thus composed of a double triangulation are in reality statically indeterminate, but may, without material error, be treated by the reciprocal diagram method.

In all cases the floor is supposed to be pin-jointed, *i. e.*, joints which cannot transmit a bending moment. The uniform load is transmitted to the joints by the members of the booms—supposed pin-jointed where they meet the bracing. It is these joint loads which act upon the structure as a whole.

It is usual to neglect the additional bending stresses set up in the members whose ends are riveted, due to their bending slightly on the structure being deformed.

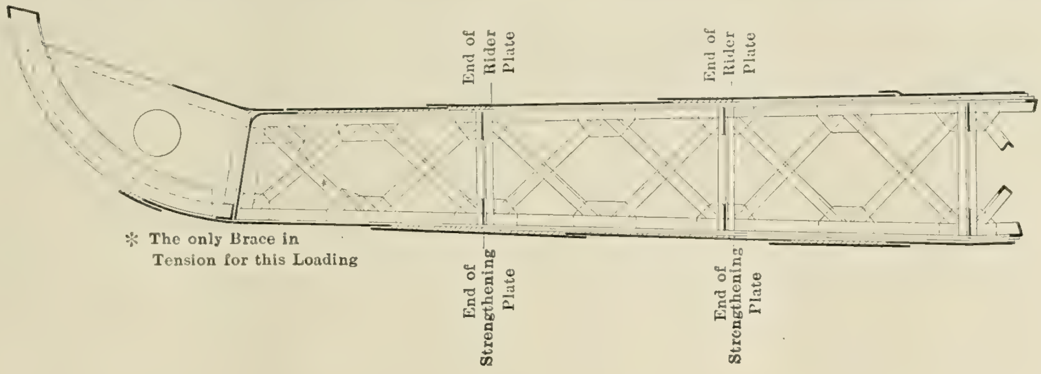

FIG. 4

Alternative Methods of Finding the Stresses in the Members

The stresses in the various diagonal and vertical members, also in the portions into which the booms are divided, may be determined by whichever of the following methods is thought advisable:

1. The braced floor is divided up into two "perfect" floors, composed of triangles, and, consequently rigid (Figs. 5 and 6); then each of these floors is treated separately by means of a

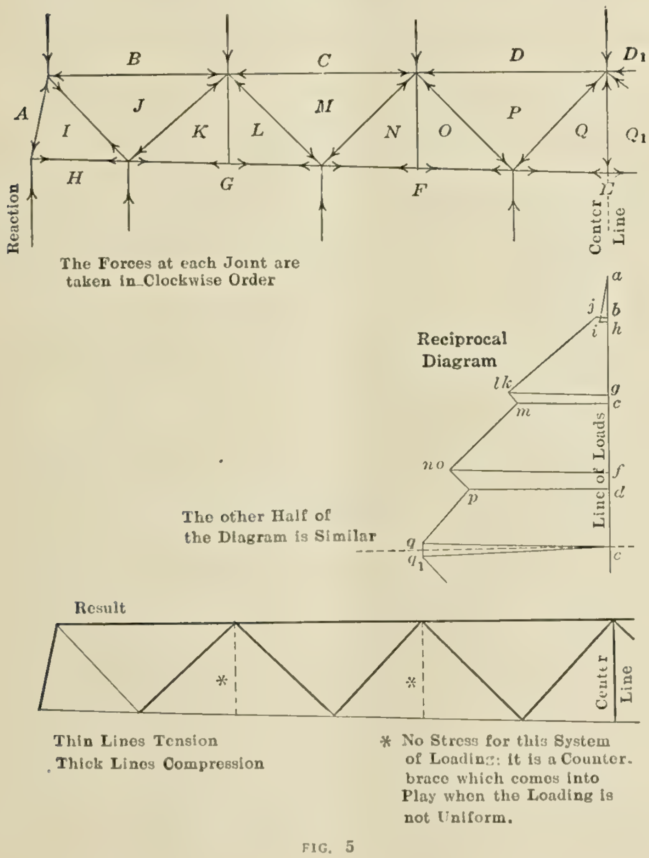

FIG. 5

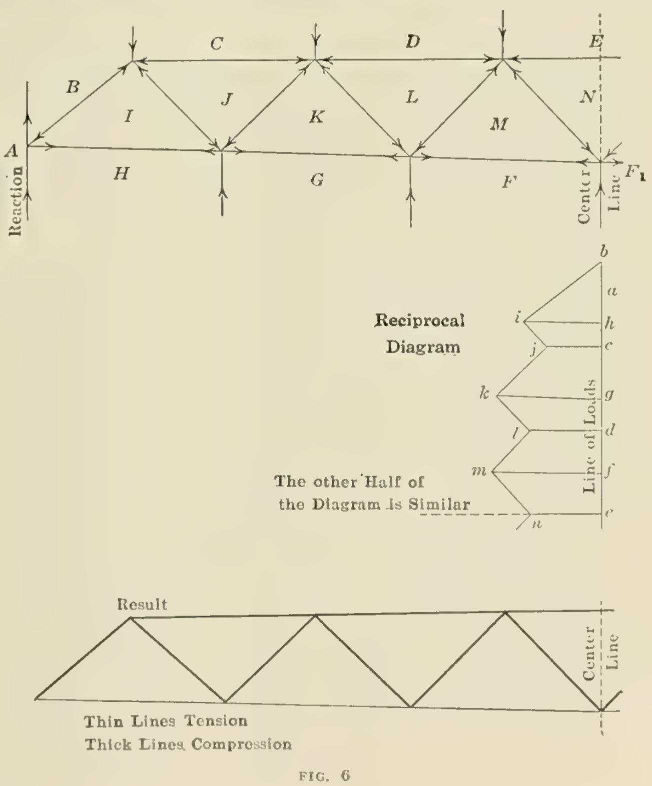

FIG. 6

reciprocal diagram, the booms being included in each case. In each component floor those loads are included which act at the apices of the triangles composing the floor, and so pass along the diagonal members to the supports. The resulting stresses give directly the stresses in the inclined and vertical members which enter only once into the component floors, but the two results for the boom stresses must be added to give the total boom stress at any point.

2. The floor is treated as it stands by means of the reciprocal diagram (Fig. 7), on the assumption that the crossing points of the inclined members, and where they are riveted together, are pin-joints. This gives the stress twice over for

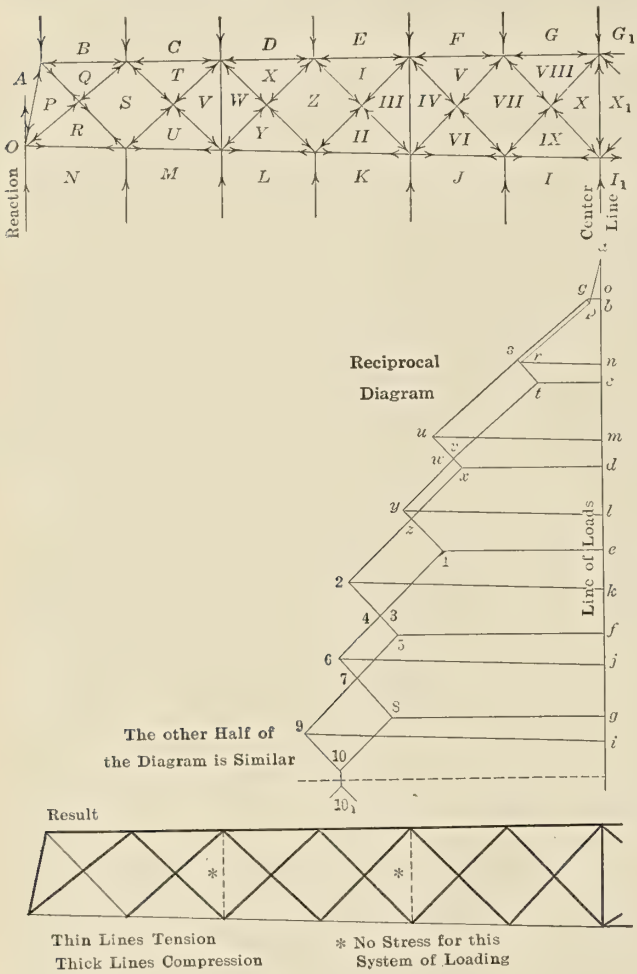

FIG. 7

the same inclined member, which stresses are not, however, additive, but confirm one another.

3. The stresses are got by the method of sections applied to each of the component floors of the first method.

The method of sections is specially convenient when the depth of the floor is uniform (vessels with very small rise of floor): but one or other of the reciprocal diagram methods is, for several reasons, to be preferred for floors of varying depth (vessels of appreciable rise of floor). The method of sections is valuable as a check for the stresses found by the reciprocal diagram, and may for this purpose be applied at several sections of the floor.

Boom Stress

When finding the boom stresses from the reciprocal diagram, we take the boom as being composed of a number of members stretching between each pair of (assumed) pin-joints where the diagonal or vertical members meet the boom. In this way we get the stress in the boom to vary in steps along its length.

We can also get the boom stress at any point from its bending moment diagram, which diagram is of great use, as it gives a graphical representation of how the strength of the boom must vary if it is to be of uniform strength along its length, that is, if its strength at any section is to be proportional to the bending moment there. To meet the requirements of increasing bending moment towards the center, the floor must, if economy of material be desired, be either of varying depth, called a "parabolic girder" from the form it takes, or of constant depth but varying thickness of boom, called a "parallel girder." The floor of a vessel with a considerable rise of floor is more of the parabolic than the parallel type, and allowance must be made for this when fixing the strength of the boom at intervals along its length, with a view to getting the same strength throughout the length of the floor.

The variation in boom strength can be got by one or more rider plates for the top boom, and one or more strengthening plates for the bottom boom (Fig. 8), the several rider and strengthening plates terminating at different points so as to

FIG. 8

grade the strength. In this way the booms could be lighter, even with the weight of the rider and strengthening plates added, than those whose section throughout is that required to meet the maximum bending moment. The thickening up of shell and inner bottom at center line assists this grading of strength.

As the strength at any point of the boom has to be proportional to the bending moment at that point, the bending moment diagram is the stress diagram for the booms, when read to the proper scale for the latter. The bending moment diagram must first be drawn for the uniform load, then to it we add the bending moment diagram for each concentrated load. To get the stopping points of the rider and strengthening plates, we divide up the bending moment diagram into strips equal in number to the plates we wish to add (Fig. 9). Projecting up the points where these strips cut the bending moment diagram,

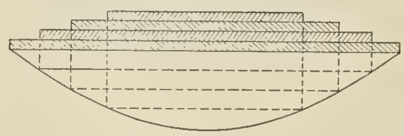

FIG. 9

we get the stopping points of the plates. The plates should overlap these points by about six inches (overlap not shown on figure).

Web Stress

The web in the case of the parallel floor takes all the shear, as the boom stress has no vertical component.

When the lower boom is inclined, as in the floor of a vessel where we have an appreciable rise of floor, the boom takes part of the shear, as the stress in this boom at any point has a vertical component which, when added to the vertical component of the stress in the bracing, must equal the shear at that point.

Weight of Floor

We can first neglect the weight of the structure and get the stresses due to cargo, pillars, water pressure, etc. The members can then be roughly designed to meet these stresses, and the weight of the structure calculated. The reciprocal diagram is subsequently modified to suit this weight. This is a lengthy process, but if each time that the weight of the floor is computed the weight per foot run is plotted on a base of total load on floor (exclusive of its own weight), sufficient spots will in a short time be obtained for running a curve which can be used to get the dead load on the floor, due to its weight alone. An empirical formula might be arrived at from the curve, giving the weight of floor per foot run in terms of the external load.

Practical Details

In arranging the practical details of construction, care must be taken that secondary stresses are not set up. These secondary stresses are those of bending, due to the following causes:

1. The stress axes (on which the center of area of each cross-section lies) of the members which come together may not meet in a point (Fig. 10a). There is a bending moment

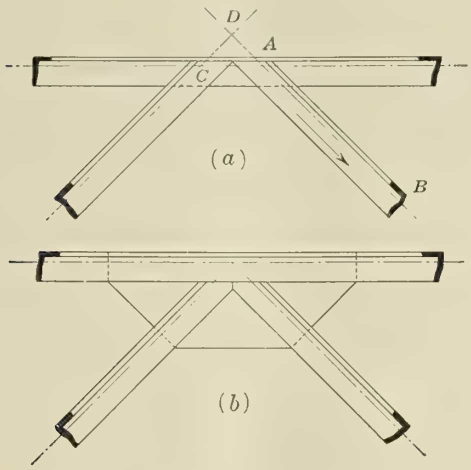

FIG. 10

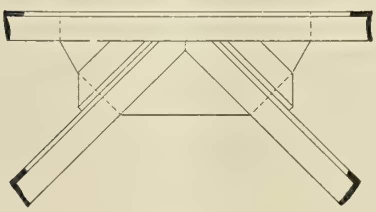

FIG. 11

at this joint equal to the pull in AB, multiplied by the arm CD, taking moments about C. This develops an extra shear in the connecting rivets. This fault is corrected by arranging as shown in Fig. 10b.

2. Members may not be loaded or attached symmetrically about their stress axes. We must avoid any eccentricity of stress in the attachments, which sets up extra shear in the rivets. The difficulty experienced in making an angle-bar connection is that of grouping the rivets symmetrically about the stress axis. To develop its full efficiency, an angle bar should be attached through both flanges (Fig. 11); unless this is done, only one flange can be taken into account when the member is in tension. If symmetry of rivets about the stress axis is unattainable, then the center of area of the rivets should lie on this line. For members meeting, the center of area of all the rivets in the connection should coincide with the intersection of the stress axes of the members.

3. Members may not be free to rotate about the joint when the loads come on, and must therefore deflect as the structure deflects. This is unavoidable with riveted joints, but, on the whole, the fixing of the joints is desirable in structures of moderate size, such as those with which we are dealing. The tension members, due to bending, owing to their ends being fixed, have more stress than that given by the reciprocal diagram which assumes pin-jointed ends, but the fixing of the ends of the compressive members strengthens them, so that their actual stress is less than that got from the reciprocal diagram. If the diagonal members are riveted where they cross, the effective length of the strut is reduced by a half, and so strengthened. It would be well to avoid the use of flat bars for tension members, although each panel is counterbraced, and to design the bracing so that it will act either as a tie or a strut, as is required by different distributions of loading.

Longitudinally Framed Vessels

To adapt what has already been said to longitudinally framed vessels, we must interchange the terms "floor" and "longitudinal." The "floor" may be taken as being made up of sections stretching between two adjacent bulkheads which support its ends simply.

Among other parts of the vessel where the open-web principle might be adopted with advantage might be mentioned partial bulkheads; middle-line non-watertight bulkheads when fitted in lieu of pillars; beams and beam connections of non-pillared vessels, etc. The last mentioned might be treated as a built-in beam of uniform strength, *i. e.*, whose strength at any point is proportional to the bending moment at that point; the half beams would be treated as cantilevers of uniform strength.

Tug Boat for Atlantic Coast Towing Trade.—The Staten Island Shipbuilding Company, Port Richmond, Staten Island, New York, launched July 22 the steel tug boat *W. B. Keene* for the Hillton-Dodge Lumber Company of New York. The hull is 150 feet long, 27 feet 6 inches beam and 16 feet 6 inches depth of hold. Propulsion is by a triple-expansion engine of 1,100 horsepower supplied by steam at 180 pounds' pressure from two Scotch boilers. The auxiliaries include a Williamson steam-steering gear, a powerful electric plant and improved fire and wrecking pumps. As soon as completed the tug boat will be engaged in towing the company's new barges between the Southern lumber ports and the Northern markets.

The Oldest Vessel in Commission.—In an article on page 372 of the September, 1909, issue of International Marine Engineering, the claim was made that the Danish sloop *Constance*, formerly an American yacht, was the oldest vessel in commission in the world. At the time this article was written the vessel was owned by Mr. J. Jeusen, of Lohals, Denmark, and had been in his possession since 1889. We are now informed that this ancient vessel has just been sold to a fisherman of Skaw in Jutland. The *Constance* was built in 1723 and is of 35 gross tons, the length being 52 feet 6 inches and the breadth 14 feet 8 inches.

Ore Shipment on the Great Lakes.—The amount of iron ore brought down the Great Lakes from the Lake Superior region in July totaled 8,204,416 gross tons, as compared with 7,600,233 tons in the same month a year ago. This establishes a record not only for the month of July in any year, but for any previous month, as it is the first month in which the figure of 8,000,000 tons has been reached or passed.

New Incandescent Lamp.—A new type of incandescent lamp is to be placed on the market by the General Electric Company, which, it is claimed, consumes only about half as much current per candle power as the present "Mazda" type of lamp. In the new lamp the tungsten filaments will be of a special shape and filled with an inert gas at a pressure of about one atmosphere.

Large Dry Dock at Quebec.—The Canadian Government is to provide a dry dock 1,150 feet long by 137 feet wide and 40 feet deep at St. Joseph de Levis, opposite Quebec, at a cost of $2,750,000 (£550,000). The contract for the construction will be carried out by Mr. H. P. Davis, of Montreal.

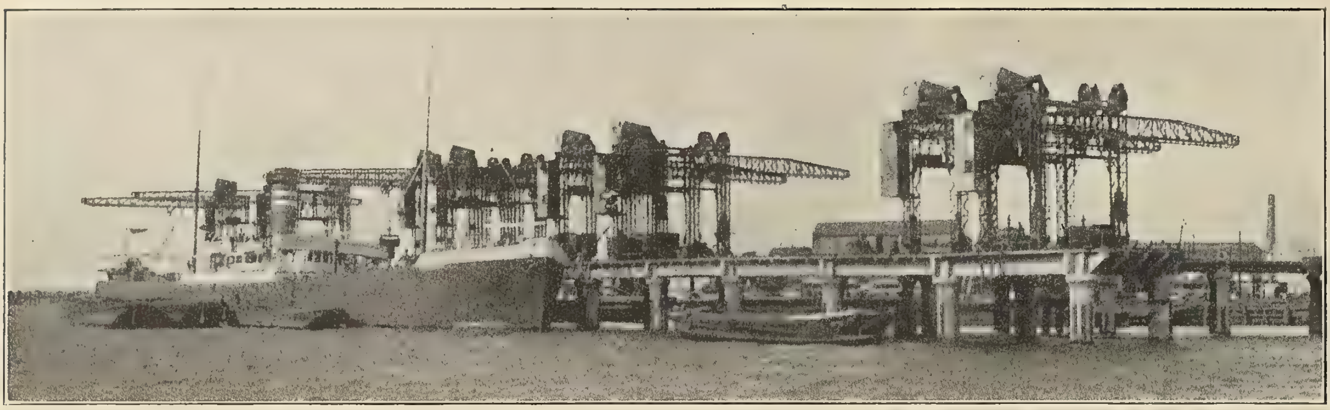

FIG. 1.—INSTALLATION OF EIGHT CRANES AT DAGENHAM DOCKS

The Transfer of Coal To and From Ships

One of the chief costs in connection with sea-borne coal is the cost entailed in transferring the fuel from the railway truck to the hold of the vessel, and from the vessel to the works where it is to be utilized. The operation of bunkering the ship also is one which is not infrequently attended with considerable difficulty, especially in ports where due attention has not been paid to the provision of modern appliances, rendering a quick and easy transfer possible.

The designs of cranes and transporters for handling coal in connection with ships is a branch of engineering possessing many special points which place it in a class by itself, and to a greater extent than is perhaps realized even by engineers, a call has been made for apparatus to meet the conditions arising out of the immense traffic in sea-borne coal which has developed more especially during the last few years. It is for this reason that it is of interest to refer to two typical coal-handling installations which present numerous features of outstanding interest in order to show the specialization which has taken place in connection with the transfer from land to water or vice versa. We are indebted for these types to the courtesy of Messrs. Babcock & Wilcox, Ltd., of London, who have during recent years made a special study of this question and have manufactured machines which possess a considerable number of novel features.

The first installation to which we may refer is that which has been installed recently in connection with the Dagenham Dock, Essex. The type of transporter which is installed there can be studied from Fig. 2, showing a three-ton electrically operated transporter crane designed for handling 100 tons of coal per hour. It will be seen that this design is a combination of an ordinary transporter and a jib crane, and it has a considerable number of special points which render it more efficient than either a jib crane or a simple transporter.

The view shows the jib or horizontal boom in its mid position, and it will be observed that, owing to the bridge construction adopted, the quay space is reduced to a minimum. Practically the whole width of the quay is available for railway wagons and the like, the crane traveling along two rails

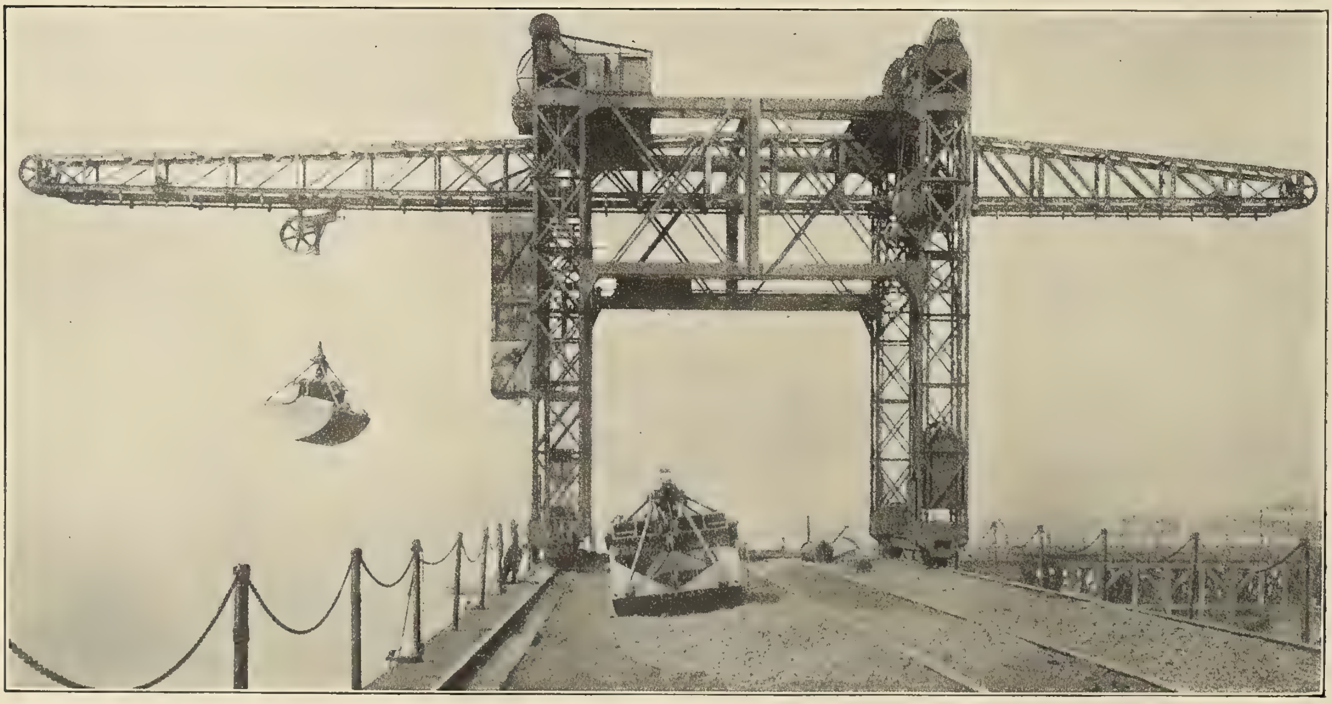

FIG. 2.—THREE-TON, ELECTRICALLY-OPERATED TRANSPORTER CRANE AT DAGENHAM DOCKS

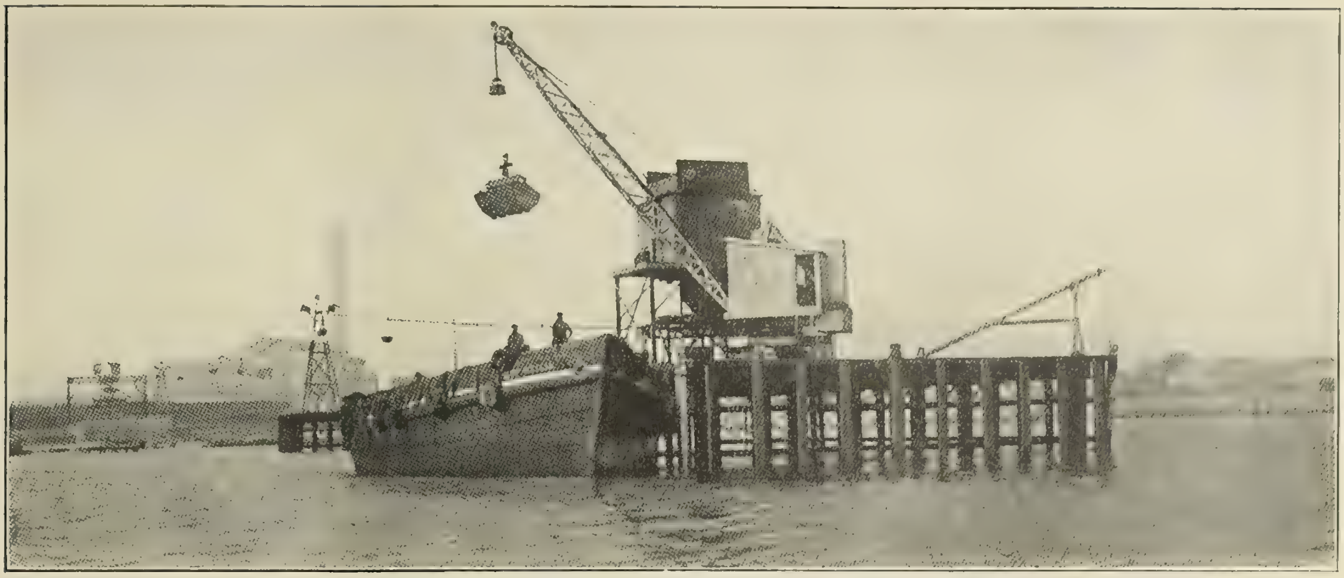

FIG. 3.—2½-TON COALING JIB CRANE AT THE USINA ELECTRICA, MONTEVIDEO

placed close to the edge of the quay, the vertical supports being comparatively narrow, and yet sufficiently rigid to give the crane great structural strength. Facilities are given to clear the masts or spars of a steamer lying alongside the quay by making the jib capable of being moved transversely in either direction.

The material is handled by grabs working on the double-rope system, the transverse motion of the grab being obtained by means of a jinney which travels along the boom. The grab is capable of being opened or closed in any position, and from actual figures it has been found that one machine is capable of handling 100 tons of coal per hour, or, working over a whole ship, about 60 tons per hour.

An important feature in connection with the crane is that the weight of the grab is balanced for all movements. This is of particularly great advantage, as it enables the size of the electrical equipment to be reduced to a minimum.

In addition to this, the machines are operated by means of a patent electric motor, which is so designed that either the armature revolves and the field remains stationary, or the field revolves and the armature remains stationary. In this way a forward or reverse motion is obtained without reversing the motor, and this novel and ingenious system of control reduces the complication of the electrical equipment to an absolute minimum.

The various motions are controlled by two hand levers, and a foot pedal controls the opening and closing of the grab. The hand levers also control the movement of the jib inwards and outwards, while an extra lever is provided for controlling the longitudinal traveling of the whole structure.

Fig. 1 shows a general view of the whole installation of eight cranes installed at the Dagenham Docks, with a ship alongside ready for unloading, and the utility of the arrangement will be at once apparent from the illustration. It may be mentioned that at the present time two large transporters of this type are being erected in South America.

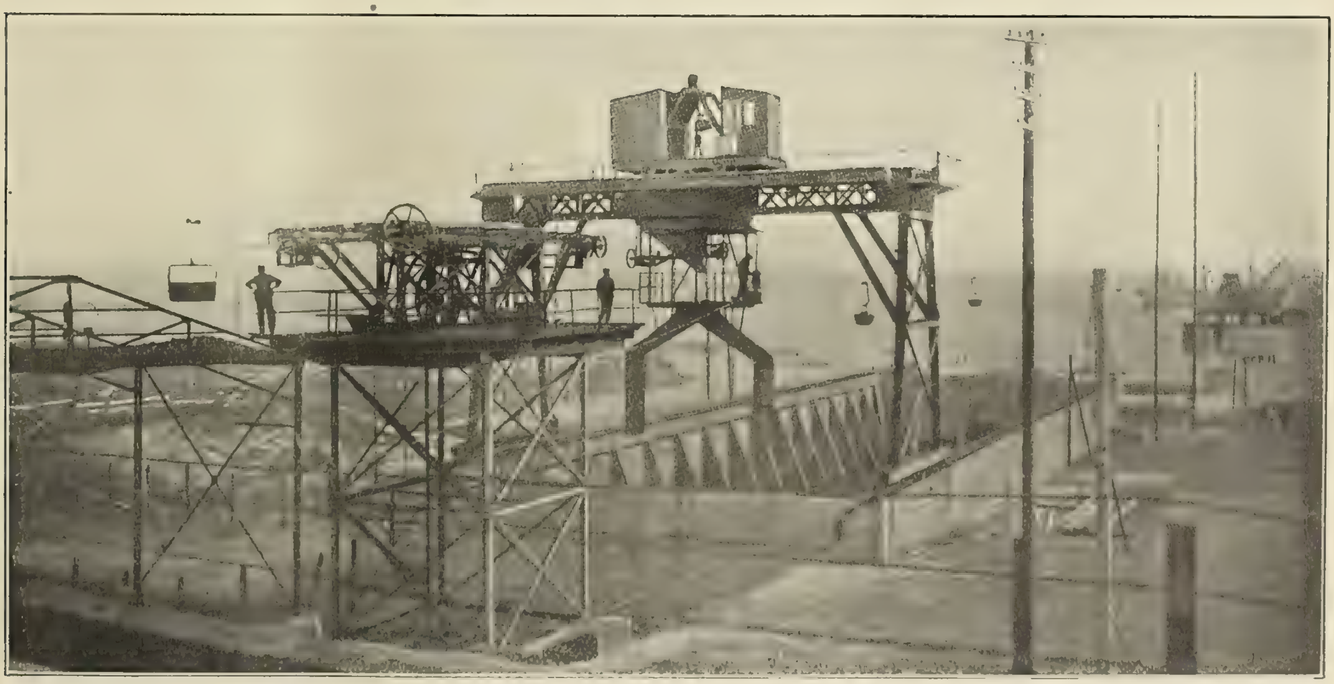

FIG. 4.—INTERMEDIATE STAGE OF COALING STATION AT MONTEVIDEO

Another interesting type of coaling equipment is shown in Figs. 3 and 4, these being views of the equipment in connection with the Usina Electrica at Monte Video. Fig. 3 shows the installation from the seaward end, and it will be seen that there is installed at the pierhead a 2½-ton electric coaling jib crane of the single motor type, having a radius of 32 feet 9 inches. This grabbing jib crane on the pier lifts the coal from the boats moored alongside and deposits the fuel in the hoppers which serve the ropeway passing landward, as will be seen in the middle distance to the left of the illustration.

Turning to Fig. 4, the intermediate stage of the installation is seen. This consists of a coal silo of large capacity, forming a coal storage for the power station which is seen in the background of Fig. 3. Over this coal storage is a three-motor goliath crane of 1½-tons' capacity and having a span of 49 feet 2½ inches. It will be seen that this crane is fitted with a bunker and duplicate shoots, and is capable of traveling outward the whole length of the silo. It also supports the loading and unloading station for the ropeway, which will be seen traveling from the pierhead in the sea to the left of the power house. This ropeway is 480 yards long between terminals, and is capable either of transporting coal from the ship, unloading coal out on the pier and the coal silos, or from the coal silos to the power station or alternatively direct from the ship unloading crane to the power station. By means of this arrangement it is seen that coal can be deposited in the silos from the duplicate shoot, it being received by the goliath crane from the ropeway. When there is a demand for coal at the power house and a ship is not available for immediate supply, the goliath crane operates by means of the grab and transfers the coal from the silo to the ropeway passing to the station. Where storage is not necessary, the buckets of the conveyor simply take the coal direct through to the station. It will be seen that by this arrangement a complete and comprehensive coal-supply system for the power house is obtained with a minimum of heavy structural work, while giving very great flexibility in the handling of the fuel, and is therefore an outstanding type of efficient coal-handling apparatus from ship to shore.

These two installations are sufficiently typical of the progress which is now being made in this department of engineering, and should therefore be of interest to all who are concerned with coal carrying or coal bunkering. The installations are therefore described at some length as indicating material British practice in this respect.

Shipbuilding in Japan

According to the annual report of the Japanese Mercantile Marine Bureau for the year 1911-1912, there were in Japan at the end of the year 2,844 steamers, of 1,386,534 gross tons; 8,192 sailing vessels, of 451,520 gross tons; and 21,817 junks. Compared with the preceding year, these figures show an increase of 299 steamers, of 152,625 tons, and of 1,800 sailing vessels, of 37,800 tons, and a decrease of 826 junks. Of the registered vessels, the increase, owing to new construction or other causes during the year, was 199 steamers, of 173,644 tons; 884 sailing vessels, of 40,803 tons, and 32 junks. On the other hand, the number of vessels lost by sea disasters and other causes was 48 steamers, of 23,300 tons; 256 sailing vessels, of 19,417 tons, and 210 junks.

At the end of the year there were 216 shipbuilding yards, excepting junk builders. Compared with the preceding year, this shows a decrease of 14 in number. The number of vessels, however, turned out by these yards during the year was 142 steamers, of 41,229 tons, and 216 sailing vessels, of 13,132 tons, which, in comparison with the preceding year, shows an increase of 65 steamers of 16,750 tons and 69 sailing vessels of 2,035 tons. The number of vessels inspected during the year was 3,409 steamers, of 3,446,470 tons; 2,626 sailing vessels, of 237,654 tons, and 199 junks. This, compared with the preceding year, shows an increase of 203 steamers, aggregating 206,524 tons, and 194 sailing vessels of 1,486 tons, while the junks inspected were less by 159 in number, aggregating 63,797 tons.

The very satisfactory growth in the Japanese mercantile marine is due very largely to the government aid furnished to shipbuilding, navigation and the subsidized steamship lines. Altogether, the number of ships completed during the fiscal year, with the grant of "Shipbuilding Encouragement Certificate," in accordance with the provisions of the law for the encouragement of shipbuilding, was 11, aggregating 50,550 tons. The number of ships to which the "Certificates" were granted, but which were not completed during the fiscal year, was 10, aggregating about 49,450 tons. The number of ships to which the "Navigation Encouragement Certificates" were granted in accordance with the law for the encouragement of navigation during the fiscal year was 17, aggregating 73,540 tons, the routes covered by these vessels including those to Europe, North America, Singapore, Ocean Islands, Hongkong, Bombay and China.

The subsidized lines coming under the direct control of the Mercantile Marine Bureau were 24 in number at the end of the fiscal year, including those lines operating on the European, North American, South American, Australian, China, Oriental, Japan Sea and home routes. Furthermore, there were at the end of the fiscal year 24 lines coming under the control of the Prefectural Authorities, and in nearly every case where orders granting subsidies to any of these lines expired during the year the orders were renewed for the same shipping companies and shipowners.

Some idea of the prosperous condition of the subsidized companies and corporations connected with Japanese shipping can be obtained from the following statements made in the Mercantile Bureau's report: The Nippon Yusen Kaisha's 26th yearly balance (October, 1910, to September, 1911) showed receipts of 28,120,599 yen: disbursements of 23,724,397 yen, and a net profit of 4,396,202 yen. Compared with the preceding year, there was an increase of 345,619 yen in net profit. The Toyo Kisen Kaisha showed a profit for the year of 716,573 yen, which, in spite of the fact that the company's receipts showed an increase of over 900,000 yen, as compared with the preceding year, nevertheless showed a decrease of 361,988 yen in net profit, as compared with the preceding year. As for the Osaka Shosen Kaisha, whose net profits for the year amounted to 1,952,822 yen, there was an increase of 712,323 yen in net profit over the preceding year. Similarly, the fifth yearly figures for the Japan-China Steamship Company, which realized a net profit of 586,049 yen for the year, showed an increase of 22,569 yen in net profit over the preceding year.

New Motor Ship.—The second motor ship for Rederiaktiebolaget "Nordstjernan," Stockholm, was launched at the yards of Burmeister & Wain, Copenhagen, June 21. This ship, which is named *Pedro Christoffersen*, is a sister ship to the *Suecia*, and is 362 feet long, 51 feet 3 inches beam, 25 feet 6 inches depth, with a draft of 23 feet 1 inch, and a deadweight-carrying capacity of 6,550 tons. Propulsion is by two four-stroke Diesel engines, developing a total of 2,000 indicated horsepower. On August 1 this vessel was taken out on her official trial trip; the engines at that time had been tried only once before on board the ship while she was lying at the dock. The official trip proved satisfactory to the owners, who took immediate possession of the ship, sending her at once to Sweden for cargo. During the trial trip the oil consumption was found to be 176. 5 Gr. per brake horsepower per hour, including the consumption for all the auxiliary machinery, steering gear and lights. The satisfactory result was obtained in spite of the fact that the oil was of poor quality, having a heating value of only 9,900 calories.

McAndrew's Floating School

BY CAPTAIN C. A. McALLISTER*

CHAPTER XIII

Feed Water Filters, Pumps and Injectors

"Having followed the steam along until it is condensed into water, our next step will be to get it back into the boiler, ready for its transformation into steam again; incidentally we will stop at one or two of the way-stations, as they say on railroads.

"After the water leaves the hot well or the air pump, it is usual to subject it to a filtering process in order to remove the grease and other impurities which become mixed with the steam as it passes through the engine. Impure water is just as bad for boilers as it is for human beings: while an occasional dose of oil is said to be good for the human system, it is never good for a boiler's 'system,' hence every effort is exerted to keep it out of the feed water. Most ships are fitted with what is known as a filter tank, which serves the double purpose of a reservoir for the feed water and a receptacle for filtering materials.

"The filter tank is customarily fitted with a number of compartments through which the feed water is drawn by the action of the feed pump—usually going up in one compartment and down in the adjoining space. By this means for a distance of from four to ten feet, according to the size of the tank, it flows through the filtering material, and the oil is supposed to be caught thereby. The material most commonly used is 'excelsior' (small wooden strings), because of its fairly good qualities for absorbing or entrapping the grease globules as well as its very cheap cost. Ordinary hay is sometimes used, but it is not as efficient as the excelsior. Sponges are used to some extent, but they are so expensive that they cannot be thrown away after becoming oil-soaked, and cleaning them to be used again is not a job relished by the oilers and firemen. A spongy vegetable substance known as 'loofa' is occasionally used, but that too is expensive and has to be washed out and replaced in the compartments. There are several patented filters on the market which utilize various woven filtering materials, such as gunny sacks, etc., but they are all for the accomplishment of one object—the removal of grease and oil, the only real, thorough cure for which is to refrain from its use entirely."

"That," interrupted O'Rourke, "is like curing a mad dog by cutting off his tail close up behind his ears."

"You have the idea all right, but you will find that both these remedies are difficult of accomplishment," answered the instructor.

"Now as to the feed tank's use as a reservoir—it should have an ample capacity for at least five minutes' supply of feed water for the boilers when the engine is running at full speed, in order to allow for the fluctuations between supply and demand in all steam plants. When feed pumps were located in the fire rooms, water tenders would have to run back and forth to see that the water in the tank was not so low that the feed pump was pumping air into the boilers, or else not so high as to be overflowing into the bilges. The proper system is to have the feed pumps located in the engine room as near as practicable to the feed tank, then by means of a float, rising and falling with the level of the water, and connected by means of rods and bell cranks to a micrometer valve in the main feed pump steam line, the system is so regulated that the water level in the tank can be automatically adjusted.

*Engineer-in-Chief, U. S. Revenue Cutter Service.

"We are now up to the subject of boiler feeding, and in this connection I will ask you: How does your supper to-night compare in importance with feeding the boilers?"

"We get our feed and some money besides, while as far as I can see all a boiler gets is its feed," said Pierce.

"No, that isn't it," broke in O'Rourke, "a boiler lives on liquid food and has to be fed all the time it is working, while we have to work all day and only get fed once in a while—and it's pretty bum stuff at that. Mr. Boiler, though, has to have his feed of the purest brand."

"That's true," replied McAndrew, "but you must remember that the boiler's stomach is only of steel, while from what I hear, you have a copper-lined stomach.

"However, I am glad that you appreciate the fact that a boiler has to be fed continually while it is working, as that is the most important thing an engineer has to contend with. If anything goes wrong with the main feed pump there is the dickens to pay, as the boiler's appetite for water allows of no delay.

"On most ships there are at least three means of forcing in the feed water—the main feed pump, the auxiliary feed pump and the injector. It would be a rare series of accidents, indeed, when at least one of these contrivances would not be available for feeding purposes.

"The most important is, of course, the main feed pump, as that has to do the brunt of the work. It is customary to make this pump of the duplex type—that is, having two steam cylinders and two water cylinders, so arranged that the valve gear of each steam cylinder is worked from the crosshead of the other pump. Some engineers prefer the simplex type, and, in my opinion, there is really very little choice, except that the simplex type costs less and occupies comparatively less space. The choice between horizontal and vertical pumps is also largely a matter of opinion, as there are engineers of equal standing who have preference for both types. The best feed pump is the one that gives the least trouble and is the most reliable, no matter whether it is simplex, duplex, horizontal or vertical."

"Which one is it?" inquired Schmidt.

"That's something you will have to learn for yourself, from your own practical experience," answered McAndrew. "I have heard good engineers argue themselves black in the face as to the relative merits of different types of pumps, and at the end neither convinced the other that he was right.

"Everybody will, however, agree that a main feed pump should be made as simple and strong as possible; that its water cylinders should be made of solid composition if you can afford it; that its steam valve gear can be readily adjusted, and that it keeps running constantly without much watching."

"How is it," inquired Nelson, "that a pump using steam of boiler pressure can force water into the boiler against the same pressure?"

"That is very simple," replied McAndrew, "as a boiler feed pump is somewhat on the principle of a lever—that is, the steam cylinders are always larger than the water cylinders. For example, a common proportion for an ordinary feed pump is to have steam pistons 8 inches in diameter driving water pistons or plungers 5 inches in diameter. Nelson, what would be the leverage in a pump proportioned like that?"

"Why, let me see," replied Nelson. "Oh! Yes, it would be 1 3/5 times as much pressure on the steam piston as it is against the water piston."

"Oh, no!" smilingly said the instructor, "you are wrong—we are not dealing with straight lines in this case; if it were a bar lever we were using to force the water into the boiler your answer would be correct, but cylinders have circular pistons, so the proportion between them varies with the squares of the diameters."

"What's that mean, sir?" said Nelson.

"By the square of any number is meant the product obtained by multiplying the number by itself. Thus the square of 5 is 25 and the square of 8 is 8 times 8, or 64; hence the leverage we gain in this particular pump is equal to 64 divided by 25, or 2.56. In other words, there is a load on the steam piston of 2.56 times that necessary for the water piston to exert a force equal to the boiler pressure. This proportion is found to be ample to insure the water being forced into the boiler against the boiler pressure, friction in the feed pipes, check valve, etc. Always remember the rule I have given you about comparing things having circular sections and you won't fall into the error I once saw a man make of fitting two 2-inch drains to carry off the water put into a tank by one

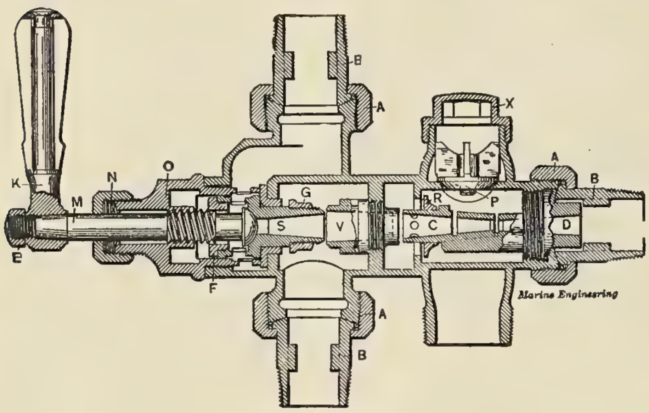

FIG. 24.—INJECTOR

4-inch supply pipe. Tell me quickly, O'Rourke, how many 2-inch drains should he have fitted?"

"Four, of course," replied the Hibernian.

"Fine work!" said McAndrew.

"A good guess," sneered Schmidt.

"There is usually only one suction pipe and one discharge pipe to the main feed pump, so that it will draw water from the feed tank and discharge into the main feed line only. There can then be no complication and no danger from opening the wrong valves when the pump is first started up. A properly proportioned pump should work easily and quietly.

"The auxiliary feed pump is, as you probably know, used in case the main feed pump breaks down. Many people call this the 'donkey pump,' just for what reason I do not know."

"I know why that old pump on this ship is called a 'donkey'—it's because it bucks and kicks so much," suggested O'Rourke.

"It must do that when you are running it, then," retorted McAndrew. "I never saw it act that way. It's all in knowing how to run a pump—you probably tried to start it without opening any of the discharge valves. I think the 'donkey' must have been on the other end.

"The 'donkey pump' is, of course, used for many other purposes than as a boiler feeder. It generally has four or five suctions and as many discharges. It can be used for pumping out the bilges, pumping out the boilers, for fire purposes and for washing down decks. When you use this pump you must be very careful to see that you open the right valves. I remember catching one oiler who was on this ship pumping bilge water into one of the boilers simply because he had opened the wrong suction valve. I fired him at once, as there is no place on this or any other steamship for such careless people.

"The auxiliary or 'donkey' pump is frequently a duplicate in construction of the main feed pump, but if possible the water end should be of composition on account of handling salt water. On all well-designed feed pumps there is an air chamber, both on the suction and discharge sides. These answer the purpose of a cushion for taking up the shock. Water is practically non-compressible, so that a sudden stroke of the pump acts like a hammer on the whole pipe system unless there is an air chamber wherein the air is compressed like a spring. No work is lost, but the shock of impact is prevented.

"There is another method of feeding water into a steam boiler besides the main and auxiliary feed pumps, and it is of such importance that every ship should be fitted with at least one. This is known as the 'injector'—an apparatus which occupies very little space but is highly efficient and often very useful. Fig. 24 is a sketch of an ordinary type.

"In the figure shown, the steam is admitted through the pipe *B*, the entrance to the body of the injector being controlled by the valve which is operated by the handle *K*. When this valve is opened, the steam rushes through the contracting nozzle *S*. The air in the space around the two openings shown is mixed with the steam and forms a partial vacuum sufficient to draw in the water through the pipe *B*. This water combines with the steam and passes into the combining and delivery tube *C D*. The steam is condensed in this tube by contact with the water, and the jet thus formed is given a very high velocity, ample to lift the check valve and force it into the boiler. It is really the energy of the inrushing steam which gives the water sufficient momentum to carry it into the boiler. The great advantage of such a device is that it acts as a feed water heater, the water going into the boiler being heated by the steam which gave it the momentum.

"For some reason or another, people who locate injectors never seem to get them piped up right. They should be arranged so that the lift of the water will be very small—not over 4 or 5 feet at the greatest—and the discharge pipe to the boiler should be as direct as possible so as to avoid any sharp bends. You have all heard the expression that 'four round turns are equal to a blank flange.' That is not exactly so, but it is nevertheless true that every round turn or right-angled bend in a pipe greatly increases the friction of the water passing through it.

"In recent years engineers generally recognize the great advantage of a feed water heater, so that no new vessel is turned out without one of these aids to economy. Ten or fifteen years ago it was not generally the practice to fit a device for warming the feed water, but now one of the greatest problems which confront all marine engineers is to get the greatest amount of work out of the least amount of coal. No single apparatus connected with marine machinery has done more to produce economy of fuel consumption than the feed water heater, a device primarily to utilize heat which has heretofore been wasted through the discharge water from the condenser. Many devices have been invented to heat the feed water by means of the waste gases from the furnaces, but the liability of accidents to the piping thus employed has practically put them out of use. Hence, nowadays, it is almost the invariable practice on steam vessels to have the feed water heated by means of a portion of the exhaust steam from the auxiliaries, such as the dynamos, feed pumps, air pump (when independent), etc. The best form of feed water heater of this class is where the steam does not come in contact with the feed water. In other words, the modern feed water heater is practically a small surface condenser where the feed water is the circulating medium. These are of various types, some having straight tubes with tube sheets like an ordinary condenser, and others having spiral coils connected to manifolds at the ends. Heat from the exhaust steam is thus transmitted to the feed water, so that it is possible to have the feed water enter the boilers at as high a temperature as 240 or 250 degrees Fahrenheit."

"I thought water boiled at 212 degrees," suggested one of the class.

"So it does," said McAndrew, "under atmospheric pressure only, but I have previously pointed out to you that the boiling point of water varies with the pressure, and in this case the pressure of the feed water is higher even than that of the steam in the boiler."

"Where does all the saving come in?" inquired Nelson.

"I'll show you," said the instructor, "as it is quite simple. We will suppose that we are using steam at a boiler pressure of 180 pounds per square inch, and that the feed water we have been using is only 100 degrees, rather cold, but still it is such as is sometimes used when great care is not exercised by regulating the circulating pump. Now suppose we have yielded to common sense and fitted the vessel with a feed water heater of the exhaust steam variety, and we find by the thermometer in the feed pipe that the water is entering the boiler at an actual temperature of 230 degrees Fahrenheit. We have thus caused a gain of 130 degrees Fahrenheit. From the 'Steam Tables' we find that steam at 180 pounds pressure contains 1,198 B. t. u. By a simple calculation we then find how much is saved, thus:

Total heat in 1 pound of steam....................	1,198
Heat in feed water as used originally (100 — 32)...	68
Heat required to form 1 pound of steam under old conditions	1,130

Under the new conditions we have saved 230 — 100 = 130 B. t. u.'s, and we find that we now only have to use 1,130 — 130 or 1,000 B. t. u.'s for a pound of steam. To find the ratio of saving we divide 130 by 1,130 and it gives 11.5 percent. Thus, if the ship has been using 100 tons of coal for a certain run between ports, it will be found after the feed water heater is fitted that 88.5 tons will do the same work. At $3 (12s. 6d.) per ton there will be a saving each trip amounting to $34.50 (£7 3s. 9d.). For 100 trips a year the saving in coal would be $3,450 (£707), or more than enough to pay for the new heater the first year it is used.

"The saving in fuel is not the only benefit to be derived, as the use of hot feed water undoubtedly prolongs the life of the boiler and prevents many leaks in the seams which result from the use of cold feed water. We might compare the bad effects of the use of cold feed water in boilers to the bad effect on a man's health of drinking too much ice water."

"Would it make his seams leak?" asked O'Rourke.

"No. But it often makes his stomach ache, and he will not last as long as the man who slakes his thirst with water only moderately cold.

"We have now followed the feed water through its various manipulations, and it is prepared to enter the boiler, except for one important essential, and that is taking the air out of it. Many of the ills which befall the interior surfaces of boilers are due to the air which enters with the feed water. There is not in general use any simple device to accomplish this, however, as designing engineers, as a rule, do not pay much attention to this important matter. If a pet-cock is fitted at some bend in the pipe, or if some obstruction is fitted in the pipe, considerable of this air can be blown off, and there are also certain automatic devices which can be used for blowing out the entrapped air. In watertube boilers where the feed water enters above the surface of the boiler water in the steam drum, the air is released to a considerable extent by having the feed water discharge against a small hood over the feed pipe nozzle, so that it enters the boiler in a spray, the air becoming separated and being carried off with the steam. There can be little corrosion in boilers without the oxygen in the air, so that the exclusion of air from the water tends greatly to reduce the pitting and corrosion.

"The feed pipes leading from the feed water heater to the boilers are usually made of seamless drawn brass or copper, and should run as nearly straight as possible to avoid friction. These pipes, as far as possible, should be run where they are easily accessible in order to detect any leaks, and by all odds the joints should be located where they will be easily accessible for putting in new gaskets, as a leaky joint in a feed pipe is intolerable."

"What's that?" said O'Rourke.

"That means something that we cannot stand for, very much like some of your questions."

(To be continued.)

On Safety of Life at Sea*

BY PERCY A. HILLHOUSE

Human life at sea is on the average exceedingly safe. Recently published figures show that during the twenty years—1892-1911—some 95,000 voyages were made between Britain and America, about 350,000 crew and over 9,390,000 passengers having started. Only one out of 332 of the crew and one out of 117,400 passengers did not reach their destination in safety. About two-thirds of the total number of casualties are found to be of a minor nature, involving comparatively small loss of life, while the remaining one-third accounts for 83 percent of the total loss.

Of all the causes of loss of shipping, that over which the naval architect can probably exercise the greatest control, is that of foundering, whether through stress of weather or as the result of collision with any obstacle whatever. The proper regulation of freeboard has a very important bearing upon such disasters. Statutory freeboard is designed to insure a suitable proportion of reserve buoyancy, and takes into consideration the type of vessel, her strength, and the extent of her erections. In most cases it determines the height of the watertight bulkheads above the load waterline, and this margin, together with the spacing of the bulkheads longitudinally and the water-excluding properties of the machinery, the coal and the cargo carried, are the elements which determine the amount of flooding which can be endured without submerging the tops of the bulkheads and so leading to total sinkage. In most large passenger vessels of modern type, the number and extent of the erections above the bulkhead deck affords also a height of platform above water which greatly reduces the danger of structural damage and loss of life due to seas finding their way on board.

Subdivision of the hull into separate watertight compartments is, in conjunction with the provision of a suitable freeboard, the most valuable means at the disposal of the naval architect towards limiting the amount of sinkage consequent upon any given extent of damage to the shell plating. Increased safety may be obtained by means of transverse bulkheads in two ways. Firstly, by increasing their height so that the vessel may sink more deeply before their tops become submerged. This was done in the celebrated *City of Paris* and *City of New York*, and is equivalent to increasing the freeboard to the bulkhead deck. The method is apt to interfere with the passenger accommodation, and unless many watertight doors are fitted, results in much inconvenience in the working of the ship. It is largely a question of convenience versus safety. Secondly, by decreasing their spacing, fitting more bulkheads, and so reducing the sizes of the holds and 'tween decks. This also tends to interfere with cargo and passengers, and increases the numbers of cargo hatches and stairways required. It should be noted, in this connection, that it is not so much a question of the *number* of adjacent compartments that may be simultaneously flooded with safety as the *proportion* of the ship's length which may suffer damage. If a ship's side

* Abstracted from a paper read before the Institution of Naval Architects, Glasgow, June, 1913.

be ripped open for any given length it is of little consequence into how many compartments that length may be subdivided. All will be laid open, and the result will be the same whether the vessel be a "two-compartment" or a "three-compartment" ship. When a ripping blow occurs the *average* length flooded will be equal to the length of the rip plus the length of one compartment, and the *maximum* length laid open will be when each end of the rip lies on a bulkhead. In this case the length flooded will be two compartments more than the length of the side cut open. The smaller the compartments, therefore, the less will be the amount of flooding, and to this extent only is a "three-compartment" ship likely to be better than a "two-compartment" design if the extra safety is obtained only by closer spacing, and not also by increased height of bulkhead.

In cases of collision with another vessel, in which it may fairly be assumed that only one transverse bulkhead will suffer damage, and, consequently, not more than two adjacent holds flooded, the vessel having the closer bukhead spacing will, of course, have the advantage, since a less volume of water will be admitted.

Great care requires to be observed when introducing longitudinal bulkheads as a means of limiting the extent of flooding, on account of the fact that water admitted to one side of the ship only will produce a heeling tendency, which may have the effect of bringing the tops of the bulkheads upon that side nearer to the water surface than would be the case were both sides simultaneously open to the sea. In spite of the loss of water plane area, the vessel's stability in the flooded condition will usually be greater than when intact, on account of the increased height of the center of buoyancy, and this fact is of much value in reducing the amount of heel produced by unsymmetrical flooding. Longitudinal subdivision is commonly obtained either by means of middle line bulkheads in machinery and cargo spaces, by wing bulkheads in engine-rooms, and between boiler-rooms and side bunkers, or by carrying the double bottom well up the vessel's sides so as to form an inner skin. Of these three methods, that of wing bulkheads appears to be the most valuable, as the wing spaces are less than those on one side of a central bulkhead, and greater than those between two skins. The central spaces containing the machinery and boilers are less likely to be rendered useless, and the wing bulkhead, being further from the vessel's side than the inner skin, is less liable to partake of any damage occurring to the outer shell plating. In cases where wing bulkheads are fitted it will probably be found advisable to interconnect the wing compartments on either side of the ship, so that both may be filled at the same time, and the vessel thus kept upright.

There are many objections to the fitting of an inner skin in mercantile vessels. Wing bulkheads already serve a useful purpose of bunker boundaries, and so do not add materially to the vessel's weight or cost; but an inner skin is a definite addition to both—it reduces the space available for cargo, coal, machinery and passenger accommodations—and on account of its comparative nearness to the ship's side is difficult to dissociate from any damage occurring to the outer skin.

Watertight decks form an exceedingly valuable form of subdivision. Very little additional weight is involved, as the deck is already required for other purposes. If the deck is above the waterline and between passenger accommodation and cargo spaces, its conversion into an effective watertight division is comparatively simple, and the only alteration involved is that of enclosing the cargo hatches by watertight trunks extending up to the bulkhead deck. If, however, there happens to be passenger accommodation below the watertight deck, it becomes necessary also to carry watertight exit stairways up to the bulkhead deck, and in most cases this would mean a considerable amount of inconvenience to passengers. Watertight doors may, of course, be fitted on such stairways, but these should be avoided as far as possible, since every additional opening affords passage to water should the closing of the door be overlooked or found impossible in case of sudden emergency.

In considering the position of the waterline to which the vessel is estimated to sink after any supposed flooding, special attention requires to be given to the possibility of water entering non-damaged compartments by way of scupper pipes, slop sheets, sanitary discharge pipes, and so on. The storm valves fitted where such pipes pass through the vessel's side are not absolutely watertight, and should the upper ends of the pipes fall below the external sea level, water may easily find its way inboard. Screw-down covers should be fitted in all such cases, and as the rate of flow would not be great, time would be available for the closing of each pipe before much additional water had entered the vessel.

The whole success of the method of subdivision hangs also upon the prompt and efficient closing of all watertight doors as soon as an accident has occurred. There are now upon the market several excellent systems by which all doors can be closed from the bridge, and in which any door is closed automatically by the rise of water on either side of the bulkhead.

In the last resort, when all else has failed, and it becomes evident that it will be necessary to "abandon ship," the safety of life at sea will depend upon the amount and nature of the "life-saving appliances" with which the vessel is equipped. It is now a generally accepted axiom that lifeboat accommodation should be provided for every person on board. The ideal life-saving appliance is one that is simple and certain in its action and by which large numbers of people can be floated safely and quickly. The whole subject has been under the careful consideration of the Boats and Davits Committee, and their final report has recently been made.

Briefly put, its most important recommendations are as follows:

The number of persons to be allotted to any open lifeboat is to depend upon its stability and upon its actual capacity as determined by Stirling's rule, instead of upon the overall dimensions and an assumed coefficient.

Development may safely be in the direction of larger boats, say 50 feet by 15 feet by 6 feet 8 inches, each carrying 250 persons and weighing 28 tons when loaded.

Decked lifeboats to have permanent bulwarks fitted with buoyancy tanks; they may be "nested" two or three deep, even although it may be necessary to raise them out of the nest by means of hand winches before they can be moved under davits.

Pontoon rafts may be accepted for 25 percent of the persons for which the ship is certified.

In foreign-going ships the lifeboats are to be transferable to either side.

Davits to have gearing to turn the boat out even against a considerable list. To have non-toppling blocks or two sets of falls if they deal with more than one boat, and wire falls with lowering drum and brake if with more than two boats.

Motor boats to be optional; in any case, not more than two will be necessary on each side of the vessel, their radius of action to be 100 miles on kerosene (paraffin) fuel.

It remains to be seen how soon, and to what extent, these recommendations will be embodied in statutory rules, but there can be no doubt that they would have an important effect upon the problem of boat accommodation and stowage. The committee has done much painstaking work in testing the stability of open lifeboats, decked lifeboats, deck seats, and rafts. Much light has been thrown upon a subject hitherto greatly neglected, and the results of their labors will undoubtedly be to encourage the development of more reliable and stable forms of all such appliances.

But when all has been said and done, I think it is certain that in the future, as in the past, safety of life at sea will depend more upon the avoidance of accident than upon its repair, and that careful navigation will prove of infinitely more value than the most minute subdivision or the most perfect equipment of life-saving appliances.

A Device to Facilitate the Coupling of Cruising Turbines*

BY HAROLD E. YARROW

Owing to the uneconomical performance of turbines when developing powers considerably below full power, attention has recently been directed to improving the economy of vessels when cruising at low speeds by the introduction of special motors, such as turbines, internal-combustion engines or reciprocating steam engines. Sir Charles Parsons has already constructed successfully turbine installations having special cruising turbines. Certain difficulties that arise from the use of an additional motor, transmitting its power simultaneously with the main turbine, may render it necessary to use the main turbine and the cruising turbine independently of one another, the vessel being driven by the one or the other, and not by the two in combination. This involves connecting and disconnecting the low-power motor from the main shaft.

The cruising turbine or engine may drive the main shaft through the medium of electrical or hydraulic transmission, or by simply throwing in and out of gear a clutch; the latter arrangement undoubtedly offers advantages, there being no appreciable loss of power, and the increased complication and cost of an electrical or hydraulic transmission are avoided. The use of a friction clutch on board ship may lead to difficulties, especially in view of the comparatively large powers that have to be transmitted. The simpler and more direct method is by throwing in and out of gear a dog clutch, so that the cruising motor can be coupled up or not as desired. This paper is not intended to deal with the design of a suitable dog clutch, but it has been prepared with a view to submitting to the meeting devices which will facilitate the coupling of the clutches.

When a high speed is demanded it is contemplated that the main turbine only will be working, and when a cruising speed is required the cruising motor only will be working, the main turbine in this case being simply driven round by the cruising motor. If the cruising motor consists of a steam turbine, the exhaust from it could, of course, be utilized in the main turbines to assist in the propulsion of the vessel. Fig. 1 represents one arrangement of turbine machinery.

Assuming that a vessel is being propelled at low speed by means of the cruising motor, which would probably convey its power to the main shaft through gearing, and it is desired to increase the speed and propel the vessel by the main turbine, no serious difficulty would be found in throwing the cruising motor out of gear by means of an ordinary well-designed clutch. It is, however, not such an easy matter to make the change from the full-power turbine to the low-power motor, because in this case the clutch has to be put into gear. This can be done by stopping the vessel, but that may not always be permissible, and if it can be avoided it is certainly preferable.

On account of the large powers now in use even when cruising, if the two shafts that it is desired to couple together are not rotating at nearly the same speed, it would not be possible to engage the clutch without involving an objectionable shock. On the other hand, if the clutch is put into gear when the shafts are revolving at approximately the same number of revolutions, it is evident no appreciable shock would be caused. It therefore becomes necessary to adopt some device by which the relative speeds of the two shafts can be ascertained; and when they are revolving at practically similar speeds the clutch could be put into gear, and the shafts then connected together. Fig. 2 shows one arrangement proposed, from which

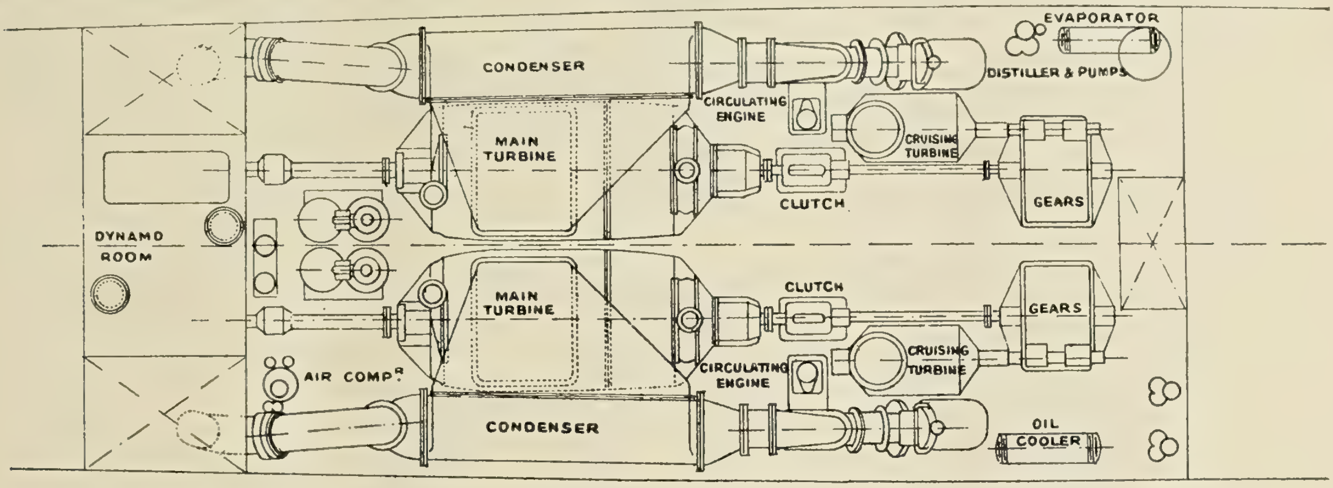

FIG. 1.—ARRANGEMENT OF MAIN TURBINES AND GEARED CRUISING TURBINES, WITH CLUTCHES FOR DISCONNECTING CRUISING TURBINES FOR FULL SPEED

it will be seen that on the outside of each coupling a screw thread is cut, the threads on both couplings being similar. By watching the thread when the couplings revolve it makes their relative speeds at once apparent, and when the screw threads appear continuous the two couplings will be revolving at equal speeds. If they are rotating at different speeds the one which is revolving the more rapidly will make the screw thread appear to be traveling faster. The optical effect produced by the rotation of the clutches upon which the screw thread is cut makes the progression of the thread or spiral line in the direction of the axis of rotation readily apparent, the eye at once recognizing any difference in speed between the two shafts.

Fig. 3 shows another method of carrying out the same idea. It will be seen that two pulleys are driven from each of the two shafts that it is required to couple together, the pulleys revolving in opposite directions. Each pulley would be attached to a short spindle having at its extremity a bevel wheel gearing in with another bevel wheel, which latter would be fixed in a revolving frame, and therefore forming a differential gear similar to that used in a motor car. If the two shafts are revolving at the same speed it is evident that the revolving frame will remain stationary, but if there is a difference in the revolutions of the two shafts the difference will make itself apparent by causing the revolving frame to rotate either in the one direction or the other, depending upon which shaft is traveling faster. On the outside of the revolving frame it will be seen a screw thread is cut so as to make apparent the speed and direction of rotation of the revolving frame. When the speed of the two shafts approximates very closely, the revolving frame will almost stop, and the coupling can be connected with the minimum shock.

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* Abstract of a paper read before the Institution of Naval Architects, Glasgow, June, 1913.

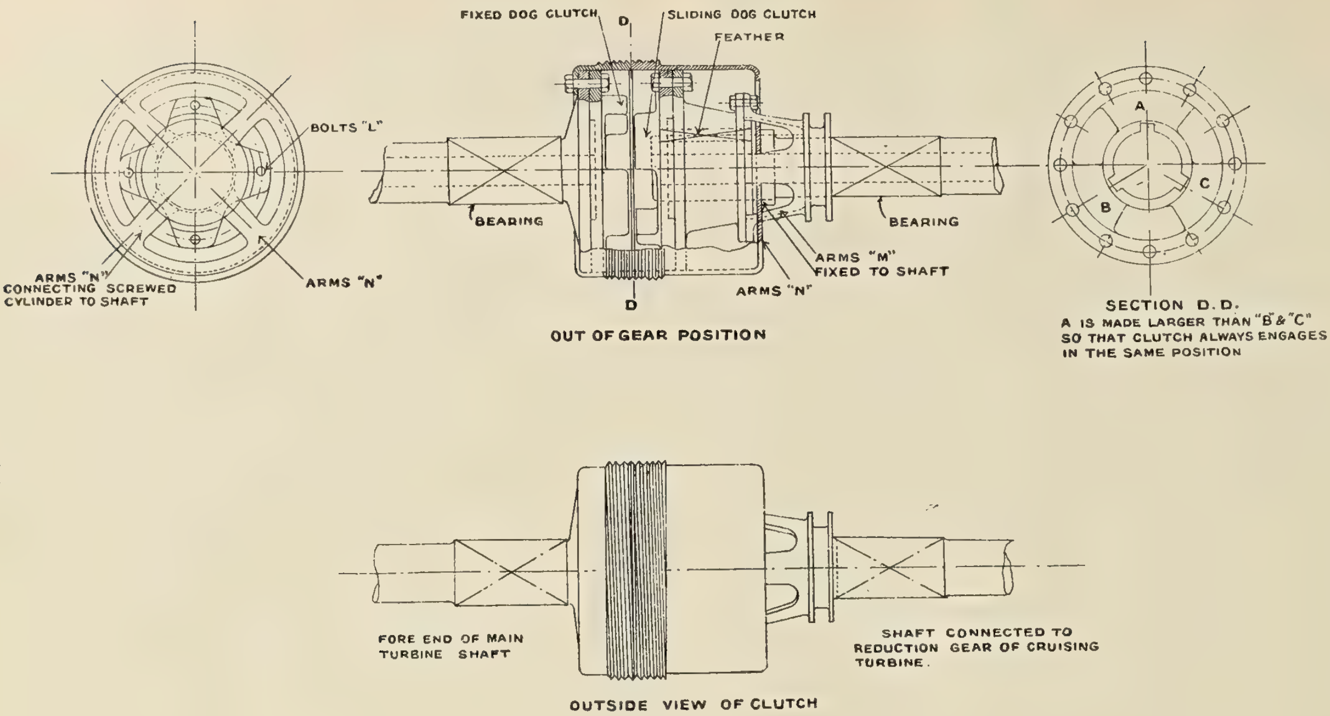


FIG. 2

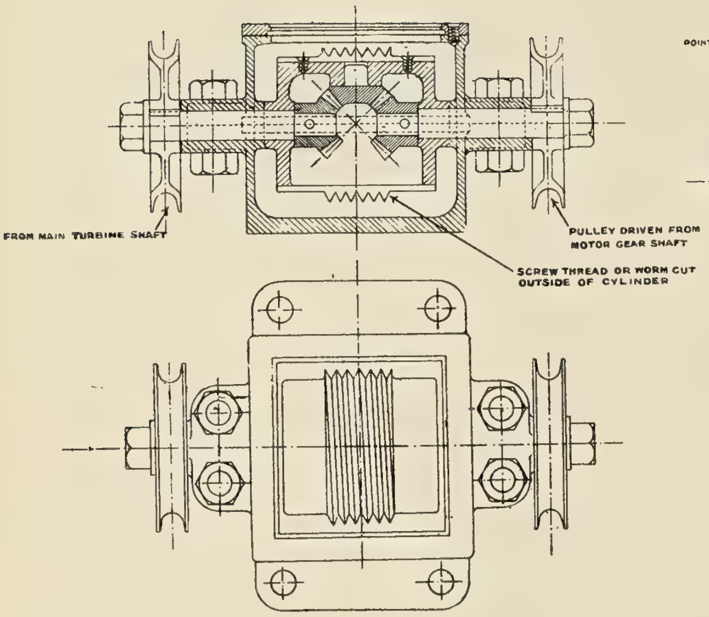


FIG. 3

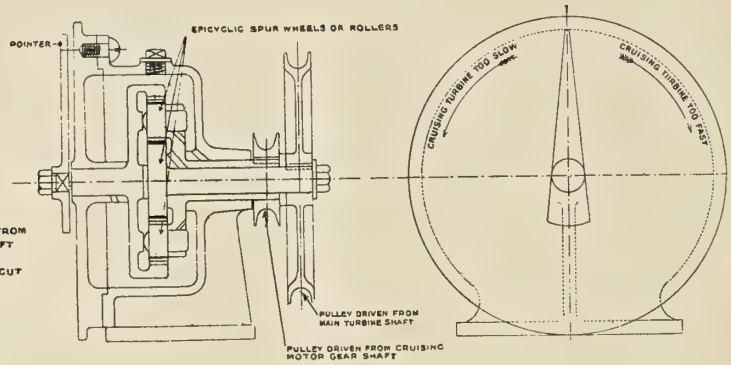


FIG. 4

Fig. 4 represents another device by which a pointer indicates the relative speeds of the two shafts.

Many other devices could be designed for effecting the same object, but it will be admitted that without some means of this kind it would be very difficult to form a correct estimate of the speed of rotation of the two shafts in line with one another.

Although such a device has not been fitted by us in any vessels, from trials made in our shops it has been found very easy to determine the proper moment to engage the clutch.

With reference to the coupling itself, in which an ordinary dog clutch is used, it is desirable that the two clutches should only be capable of being put into gear, so that the same faces are always in contact with one another, because with the greatest possible accuracy in workmanship it may be found that the work will not be taken up equally by the different surfaces in contact, and the faces of the clutch will readily wear. Therefore, it is submitted that whatever clutch is adopted the same faces should always be in contact, and this can be effected by the projections of the dog clutch being of unequal size.

Another point which should be borne in mind in connection with such clutches is to design the bearings which support the shafts close up to the clutches, so that they should not be subjected to unequal wear. This is necessary, because if there is a difference in the amount of wear to which the two bearings are subjected, causing the shafts to get out of line, the want of alinement thus arising between the two clutches will cause movement between them and lead to trouble. For this reason it may be desirable that a certain length of shaft should be interposed between where the power is transmitted and the clutch, which would allow for the unequal wear of the main engine or turbine bearings; while the special bearings which have only to support the weight of the shaft near the clutches may be considered as likely to wear evenly.

Monthly Shipbuilding Returns.—The Bureau of Navigation reports 132 sailing, steam and unrigged vessels of 38,207 gross tons built in the United States and officially numbered during the month of July. Eight of these vessels were steel steamships aggregating 26,633 gross tons, of which four, totaling 15,655 gross tons, were built on the Atlantic Coast; three, aggregating 9,400 gross tons, on the Great Lakes, and one, of 1,578 gross tons, on the Pacific Coast.

Laying Out Propellers*

In the following article is explained a method of laying out propellers which the writer has used at the works of the Trondhjems mekaniske Vaerksted for the last six years. The method has been found very satisfactory, both in the drawing office and in the foundry. Of course any method for developing a screw-thread surface on a plane surface is inexact, but the method explained has been found sufficiently accurate for all practical requirements. Figs. 1 to 3 show the method of laying out the propeller in the drafting-room; Fig. 4 shows an adjustable guide-curve device used for molding propellers; while Fig. 5 shows the details of this device. The guide-curve device has been in use at the works mentioned for the last two years, and has proved very satisfactory as a saver of both time and material. The halftone shows a model guide-curve device, 9 inches long, placed beside a wooden model, which represents the propeller mold, and which is marked off from the propeller drawing. Fig. 5 gives the main dimensions for a full-sized device in use in the works. The guide-curve can be adjusted, ready for use, in from 10 to 15 minutes.

The method of laying out the propellers and the use of the guide-curve device can be best explained by reference to a specific example. The dimensions of the propeller to be laid out are supposed to be known. In this case, the diameter is 14 feet, the pitch is 16 feet 6 inches, and the area of the developed surface of the blade 61 square feet. The back-throw abaft the propeller hub is 6 inches.

In the plan, as shown in Fig. 1, first draw a section of the blade and the hub; then draw an arc of a circle *G*, passing through the tip of the blade. Mark off on the radius *OG* any number of points *A*, *B*, *C*, etc., and draw arcs through these points with *O* as a center. On arc *G* set off any number of equal distances 1, 2, 3, etc., and 1′, 2′, 3′, etc., on each side of the center line *OH*, and draw radial lines from the points thus set off. In the present case each of the divisions on arc *G* is 6 inches.

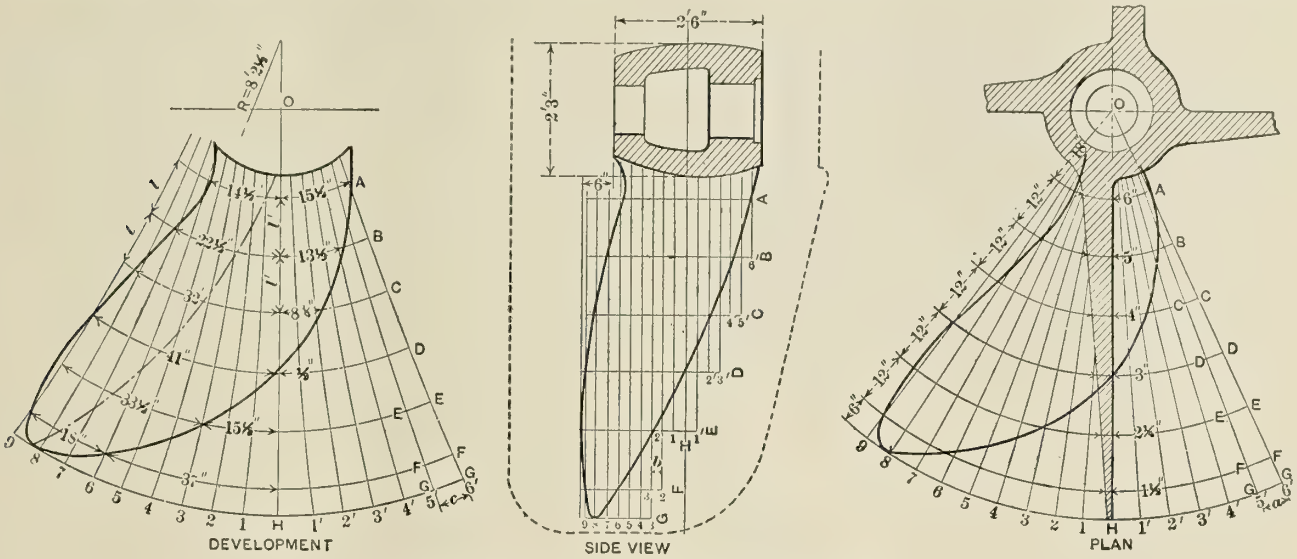
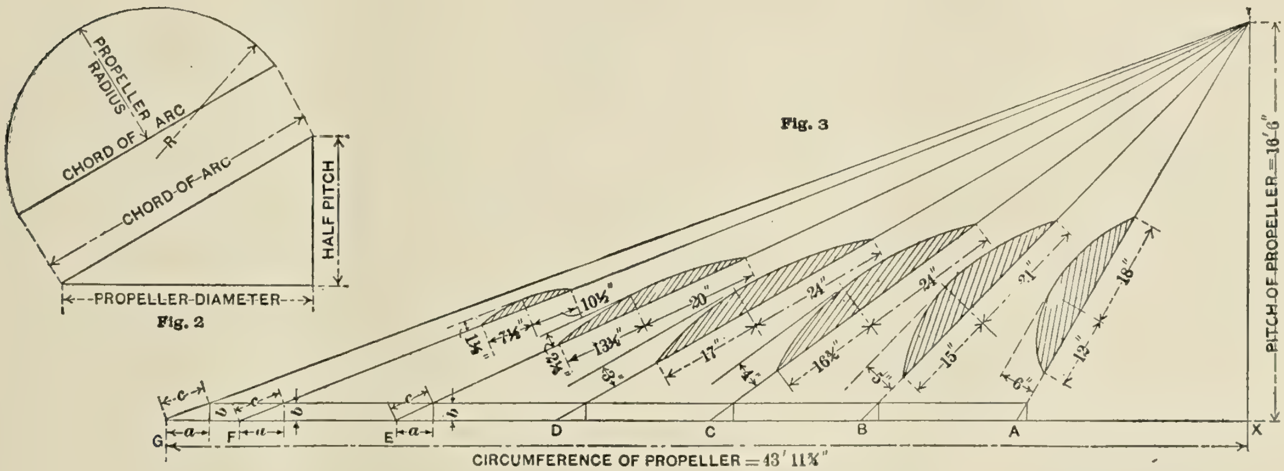


FIG. 1.—DEVELOPMENT, SIDE VIEW AND PLAN OF PROPELLER



FIGS. 2 AND 3.—METHOD OF LAYING OUT PROPELLERS

Lay off to any convenient scale the horizontal line *GX*, Fig. 3, which represents the circumference of the propeller at the tips of the blades, and let the distances *AX*, *BX*, *CX*, etc, represent the circumference at points *A*, *B*, *C*, etc., in the plan, Fig. 1. The vertical line *XY*, Fig. 3, represents the pitch of the propeller. Join the points *A*, *B*, *C*, etc., with the point *Y*, as shown. These lines show the angle of the propeller blade sections. In the side view, Fig. 1, draw the longitudinal section of the propeller hub and the propeller aperture. The hub must be placed in its proper position in the aperture so that the exact clearance of the propeller can be seen. The aperture is indicated by dotted lines. Also divide the space for the side view of the blade, by vertical lines, into a number

* From *Machinery*.

of equal spaces corresponding in number to the divisions in the plan.

Set off on the base line at *G*, Fig. 3, any one of the distances on arc *G*, Fig. 1. In the present case, assume that the distance *a* in the plan is transferred as indicated. Distances *b*, Fig. 3, are equal to any of the distances *H*-1, 1-2, 2-3, etc., in

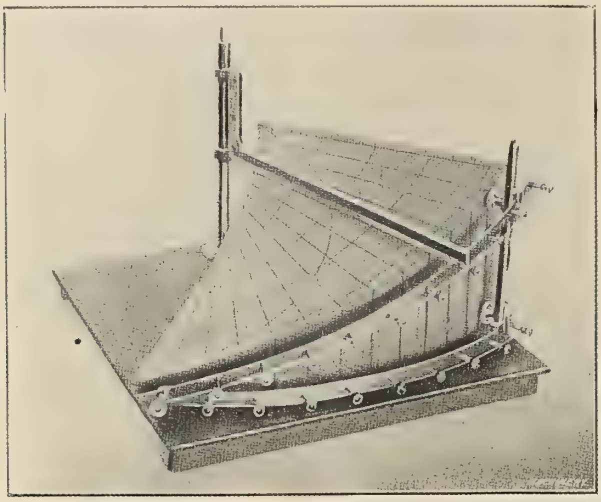


FIG. 4.—MODEL OF GUIDE-CURVE DEVICE FOR MOLDING PROPELLERS

the side view. As the propeller has a uniform pitch, the height *b* will be the same for all the small triangles shown at the base in Fig. 3. The base *a* of the seven small triangles, however, is equal to the distances *FF, EE, DD*, etc., on the arcs *F, E, D*, etc., in the plan view. The hypotenuse *c* in each of the small triangles is now equal to the distances *GG, FF, EE*, etc., in the development in Fig. 1.

Next calculate the radius of arc *G* in the development. As is well known, the radius in the development view will not be the same for two propellers of equal diameters if they do not have the same pitch. The easiest way to determine this radius is as follows: Draw a triangle, as shown in Fig. 2, where the base equals the diameter of the propeller, and the height equals one-half the pitch. The hypotenuse of this triangle will then be equal to the chord of an arc, the versed sine of which equals the radius of the propeller, and the radius of which equals the radius of arc *G* in the development.

The formulas for the calculation of the radius *G* of the development are as follows (see Fig. 2):

Let C = chord of arc,
D = diameter of propeller,
P = pitch of propeller,
R = radius of development of propeller blade surface,
Then

$$C = \sqrt{D^2 + (\tfrac{1}{2}P)^2}$$

$$R = \frac{(\tfrac{1}{2}C)^2 + (\tfrac{1}{2}D)^2}{D}$$

The radii for arcs *A, B, C*, etc., in the development, Fig. 1, are determined in a similar manner. In the development, the same center can be used for all seven arcs if the pitch is small, but for large pitches it is necessary to move the center upwards for the smaller arcs, otherwise the distances 1 will be somewhat longer than distances 1′, as the lines in the development are not radial. Set off a sufficient number of distances 1, 2, 3, etc., and 1′, 2′, 3′, etc., on both sides of the center line *OH* in the development. Set off on the arcs *A, B, C*, etc., the distances *c* as found from Fig. 3, *c* being the hypotenuse of the seven small triangles, as already explained. Through the points thus determined draw slightly curved lines which represent the radial lines in the plan and the vertical lines in the side view. Then, in the development sketch in, by free hand, the propeller blade to about the required shape, and measure the area by a planimeter. Small alterations may have to be made in order to get the right area.

On the radial lines in the plan and the vertical lines in the side view mark off the points where the contour of the blade crosses the radial lines in the development, and then, by free hand, sketch in the contour of the blade through these points, so as to get the shape of the blade in the plan and side view. It must be remembered that the shape of the blade in the side view is not what it would appear to the eye, but is the exact opening required for the blade when revolving. The curve of the propeller hub in the development is found by taking the vertical distances between the horizontal line *A* and the propeller hub in the side view.

The use of the guide-curve for laying out propeller blades in the foundry from the drawings will be apparent from the illustration of the device itself.

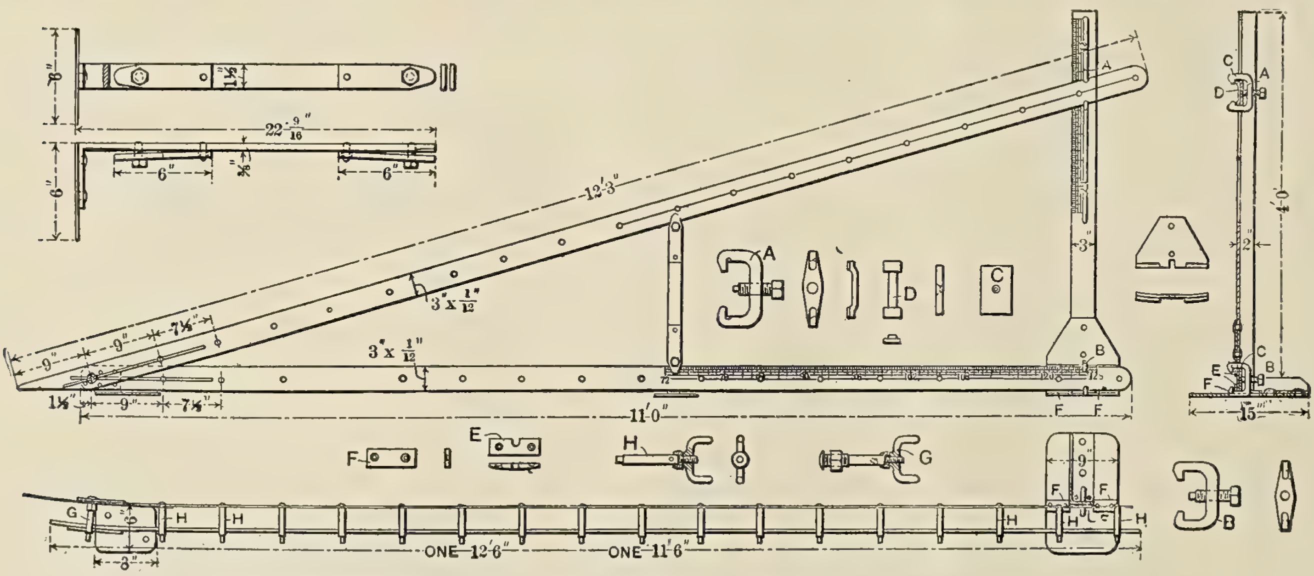


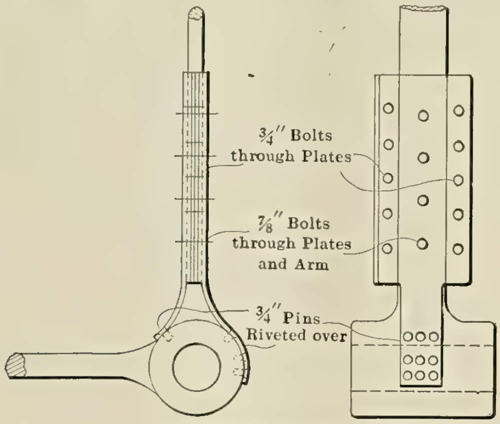
FIG. 5.—DETAILS OF FULL-SIZE DEVICE MADE ON SAME PRINCIPLE AS THAT ILLUSTRATED IN FIG. 4

Letters from Practical Marine Engineers

Incidents Relating to the Design, Care and Handling of Marine Engines, Boilers and Auxiliaries; Breakdowns at Sea and Repairs

Repair to a Damaged A Bracket of a Turbine Steamer

One of the A brackets which support the outboard propeller wing shaft of the turbine steamer *A*——— had struck an obstruction and cracked at a point near the boss. The following repair was effected: Two pieces of ½-inch plate were obtained and cut and bent to suit the shape of the arm and boss as shown. These were beveled off on the ahead side with a hammer and chisel. Holes were drilled in the plate as shown



REPAIRS TO A-BRACKET

and the plates fitted in position and holes bored in the boss and arm to suit. The holes in the boss were tapped ¾ inch Whitworth thread; and the corresponding holes in the plate being countersunk, ¾-inch screwed wire was screwed in and riveted over. The holes in the arm were made clearing holes to take ⅞-inch diameter bolts. This temporary repair answered very well until the steamer was brought up for a thorough overhaul, when it was removed in good condition.

Glasgow. "ISON."

Bearing Pressure on Guide of Paddle Engines

A skeleton drawing of the side elevation of an ordinary diagonal engine, such as is commonly used in paddle steamers, is shown. The engine is usually placed in the ship with the cylinders furthest aft, as shown, the direction of revolution for going ahead being, of course, as indicated by the arrow. Consider the case of the engine going ahead, the crank and the connecting rod being in the position indicated by the full lines *O C* and *P C*.

The piston is being urged forward by the steam, and hence the piston rod and also the connecting rod are in compression, the thrust on the connecting rod being in the direction *P C*. Obviously the direction of the thrust on the guides is downward, viz., *R P*.

Next imagine that the crank has traveled round to the position indicated by the dotted lines *O C′* and *P C′*, the engine going ahead as in the previous case. In this instance the piston is being pulled back, hence the piston and connecting rod are in tension instead of in compression, as in the previous case, and the pressure on the guides is still in the same direction—namely, *R P*—and not, as some people imagine, in the opposite direction. It may be momentarily in the opposite direction, due to the wheels carrying the engine over the dead center, and hence placing the connecting rod and piston rod in tension for a small fraction of the return stroke, but the main point is that the pressure is chiefly in one direction for a certain direction of rotation of the engine.

The explanation of this may not seem quite clear when set down on paper, but a simple experiment performed with a pair of hinged rods will illustrate the direction of pressure to those who do not at first quite grasp the explanation. It may be noticed, by the way, that in screw engines one guide surface is usually much smaller than the other, the smaller being the astern surface, and as the engine seldom goes astern for long this can afford to be made smaller, whereas if the pressure alternated equally between the two surfaces these surfaces would naturally have to have the same area.

It was suggested to me some time ago that if paddle engines were placed in the ship in the opposite direction—that is, with the cylinders farthest forward—the loss of power due to friction on the guide surfaces would be materially reduced. With the engine placed in the ship with cylinders farthest forward, the direction of rotation for going ahead will be opposite to that indicated by the arrow in the sketch. The case is similar to that of the engine in the sketch going astern.

In the first instance which we considered the pressure on the guides for going ahead is equal to the load due to the steam

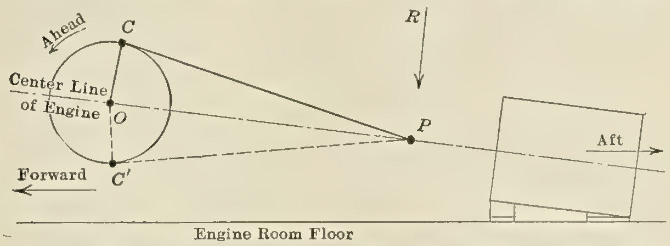


DIAGRAM SHOWING BEARING PRESSURE ON GUIDE OF PADDLE ENGINE

plus the weight of the crossheads, connecting rods, etc., while in going astern the total bearing pressure is reduced by the load due to the weight of these parts. Hence it will be seen that in Case II the bearing pressure on the guides for going ahead is less than that of Case I. If this weight of the crossheads and connecting rods is considerable, the method of placing the engine in the second case—namely, cylinders farthest forward—should result in a decrease of power lost due to friction on guides. It may be possible that there are objections to this method or that the decrease in lost power is not so great as it may seem, which would account for the fact that paddle engines are not, so far as the writer is aware, placed in the ship, as in the manner suggested in the second case. "M."

Glasgow.

An Indicating Curiosity

Indicating a steam engine presents some pretty possibilities; extraordinary results can frequently be attributed to faulty rigging up, stretch of cord, friction of indicator piston, length of connecting pipes and condensation, all of which play their part in rendering the results obtained inaccurate.

A good, practical engineer, otherwise normal and sane, was puzzled for a long time as to the reason he failed to get boiler pressure as the initial pressure in the high-pressure cylinder.

Twenty or thirty feet of steam pipe, even if covered adequately, always results in an appreciable drop in pressure, as shown by the indicator diagram. After this idiosyncrasy of his was known, his juniors used to shift the atmospheric line to make a peaceable engine room.

A point in connection with indicating seems of some moment. This concerns the vertical admission line of the diagram. This is usually cited as proof of the instantaneous rise in pressure in the cylinder as soon as the valve opens to steam. When considering the actual application of the indicator, one is less sure about this instantaneous rise in pressure. It is obvious that the valve takes time to open, while the admission line is square or nearly so to the atmospheric line.

Consider for a moment, however, the usual attachment of the reciprocating cord to the indicator drum. The piston has its maximum velocity at the center of its stroke, while, when passing the dead center, there is no lateral movement to the piston. The attachment of the cord to the crosshead by means of reducing lever gives two dead points to the movement of the indicator drum; one of these is coincident with the admission line of the diagram.

The movement of the diagram paper past the pencil is therefore greatest at the center of the expansion line and least at the ends of the stroke. As a consequence, a bad admission line is a rarity in a diagram, and when found means considerable fault with the setting of the slide valve. Want of coincident line between the edge of the steam port and the edge of the valve is not under these conditions made apparent.

It should be possible to meet the case by the use of two coupled drums revolving steadily by mechanism resembling the works of an ordinary clock. The diagram obtained would then be a series of waves, to some extent similar to the turning effort diagram of a crank. This would give an analysis of the admission line of the diagram not possible under the ordinary indicator method, the drum in the latter case remaining stationary when the admission line is formed by the indicator pencil.

A result similar in effect can be obtained in a compound engine by obtaining the indicator-drum motion from the other crosshead; such diagrams are puzzling at first sight, but it is obvious that admission is not an instantaneous rise. Of course, mean effective pressure cannot be calculated either with the suggested method of two drums or with crossed cords.

A curiosity never previously commented upon, to the writer's knowledge, was brought under notice recently.

A steam engine, running under a brake using a constant load, varies in horsepower directly as the revolutions. Double the revolutions, and the effect is to double the horsepower. It is surprising, using an integrating counter reading directly as revolutions per minute, the difference 5 pounds' variation in steam pressure has upon the revolutions. As a matter of fact, the difference between 155 and 160 pounds has an effect upon revolutions quite in excess as a proportionate increase. In effective result in a steam plant, it is the last 5 pounds which counts, and the closer steam can be kept to the maximum limit of blow off, the greater the enonomy of the job. Careful attention to full steam has a marked effect upon coal consumption.

The curiosity is this: Take any slide valve engine, having link reversing gear, and place same under friction diagram conditions. The steam entering the cylinder then simply serves to overcome the friction losses of the engine. When steady conditions have been obtained with regard to revolutions, now link up the valve gear, and it will be found that the revolutions of the engine increase 10 percent. This increase in revolutions is most marked when the engine with gear full out is just turning over the centers.

The explanation is simple: The steam entering the cylinder is very small in amount, and linking up has no effect upon so small a quantity. The greatest internal loss in the engine is the friction of the slide valve; by linking up, the travel of the valve is shortened, hence the increase in revolutions.

London. A. L. Haas.

The Care of the Dynamo on Board Ship

Electricity for use in lighting and for auxiliary power purposes is now becoming so increasingly popular in connection with the mercantile marine that it becomes part of the duty of every marine engineer at one time or another to handle the ship's dynamo. So far as the mechanical part of the work is concerned, every man worth his salt will know the difficulties which arise, and it is not intended to say very much about this part of the subject in these notes. Electricity, however, is a rather curious and sometimes a dangerous thing to handle, unless those in charge of it know exactly how to carry out the necessary work in connection with it, and for this reason it has been thought advisable to write one or two notes about the way in which the main dynamo should be handled, more especially from the point of view of the way in which any difficulties in its running should be cured.

In the present set of notes only one point will be dealt with, and that is the difficulty that very frequently occurs owing to the brushes sparking while the dynamo set is running. This may be due to a number of causes, and it is necessary in order to get the matter put straight that these causes should be properly understood. One of the most frequent causes of sparking of the brushes is due to a dirty condition either of the brushes or of the commutator (by which is meant the revolving set of bars on which the brushes rest in order to collect the current from the armature), or both. Dirt is as great an enemy to successful work with electrical apparatus as it is with mechanical. Even a beginner in mechanical matters knows the importance of keeping dirt out of the bearings, and it is equally important to keep dirt off the commutator. Where, as in an engine room, flying dirt is frequently of an oily nature, this oily deposit is liable to form a film on the commutator, and under the action of the heat from the armature it becomes a hard deposit. An electrical engineer should therefore early learn how to distinguish the clean, bluish purple skin formed on the commutator by successful running, and the black, opaque, grimy deposit formed of carbon dust or other dirty matter combined with oil caked onto the commutator, and giving a very good chance for the electric current to bridge across from one brush to another and so cause a breakdown. The brushes also should be very carefully examined from time to time to see whether their surfaces are in good condition, as upon examination of this sort very largely depends the treatment which has to be given to the brushes, brush gear and commutator.

The time is, of course, gone by when the marine engineer finds himself under the necessity of lubricating the commutator with an oil can at the same time as he is attending to the bearings, although cases have been known where misguided juniors have thought that the commutator is best served by lubricating it occasionally. This is a mistake. If the commutator shows signs of harsh running, evidenced by a squeaking noise, the only lubrication to be given is the slightest touch of pure vaseline, applied very sparingly with a soft rag. Anything more than this is detrimental both to the commutator and the brushes. If in the first instance the commutator appears to be dirty, the best way to get it into good condition is to lift the brushes, and then to take a rag, not too freely saturated with the kerosene (paraffin), and cleanse the surface of the commutator from the oily deposit which it may have. If there is nothing more wrong with the commutator than dirt it will probably be found that the machine will run satisfactorily.

Examination of the brushes will always be a useful thing. Nowadays modern dynamos are almost universally provided with carbon brushes, the old copper wire gauze brush having gone out of fashion, and with it a large amount of sparking. On taking the carbons out from the holders it may be found that these have accumulations of oily and dirty matter on them. These should, of course, be carefully cleaned off. On looking at the end of the carbon brush where it presses on the commutator, there may be signs that it has only been rubbing over part of its surface. It is easily seen by inspection which part has touched and which has not, and instructions will be given in a few paragraphs as to how to bed the brush down properly. It may be said here, however, that bad bearing of the brushes on the commutator is a very fruitful source of sparking. It may also be noticed that on the front edge of the brush there are signs of burning or metal deposit on it. This means that violent sparking has at some time or another been occurring, and must be put right. All these indications are of considerable value to the experienced electrician in deciding him as to what to do in order to cure sparking troubles.

Dealing first of all with the more ordinary troubles in the commutator causing sparking, many a commutator has been ruined because the engineer has not taken the matter in time and prevented a small trouble from developing into a large one. Supposing that after cleaning up with kerosene (paraffin) in the way described above, and setting the machine to work, the brushes being properly adjusted as described below, the commutator still continues to spark, it is very probable that one of the copper bars is perhaps of softer metal than the others, and the heating and rubbing of the brushes upon its surface has worn that bar down quicker than the others close to it, with the result that every time that particular bar passes under the brush a spark occurs. Then this spark itself causes the copper to melt and form copper vapor, and thus the process goes on at a still more rapid rate. The best way to get over this is to note whether any particular bars seem pitted or corroded while the others are in good condition. When this is the case a block of wood should be taken and cut out to the same curve as the circumference of the commutator. A sheet of very fine glass paper should then be placed, sand side out, in the curve of the block of wood, and while the dynamo engine is run with the brushes lifted this should be pressed lightly but firmly on the surface of the commutator. The glass paper will take a slight skim off the high bars, and finally the whole surface of the commutator will be brought up to a true cylinder. This will give a soft commutator bar a fresh start, and providing that it is properly attended to afterwards it is very likely that the trouble will not happen again. Of course, there are troubles in the armature and armature connections which may interfere with the proper working of the commutator bars, but these will have to be dealt with later.

Another thing which sometimes causes bad sparking is that the mica strips which are inserted between the bars of the commutator may be of harder substance than the copper itself, and when the commutator is running these strips are more durable than the copper. In this way a lot of small ridges are formed around the commutator, and the copper gradually wears down more quickly than the mica. The result of this is violent sparking all round the commutator, and the only way to get out of the trouble is to frequently clean down the commutator with glass paper in the way described above. It should be remembered that emery cloth is not to be used in place of glass paper, as there is danger of the emery giving rise to a flash-over. After the commutator has been cleaned in this way it should be carefully wiped down, and if there is a pair of small bellows handy any copper dust ground off the commutator should be blown out or else there may be trouble. When the brushes are again let down onto the commutator a slight touch of vaseline should be given as a lubricant.

Sparking trouble may, however, be caused not by the condition of the commutator itself, but by the condition of the brushes, or the way that they are applied to the commutator. It is very often found that the material of the brush itself is not quite suited for the work it has to do, and if after trying the remedies described below the sparking does not improve, it is advisable to try a change of carbon brush of either a softer or harder variety, according to circumstances. It is important that the material of the brush should be as uniform as ever possible, as a single hard portion in the brush may cause quite a lot of scoring and sparking. Examination of the brush end will sometimes show a hard patch of this sort, and it is a very good plan to scrape this away carefully with a penknife and then re-bed the brush onto the commutator. The best way to bed brushes when they show that they are not sitting properly on the commutator, or if they have been cleaned and scraped, is to let them down onto the commutator in their normal position, previously having laid over the surface of the commutator a strip of fine glass paper with the glass side outwards. When the brushes are let down onto this, the strip should be drawn gently backwards and forwards, bearing down upon the surface of the commutator so as to keep the curve right. In this way the ends of the brushes will be cut to the shape of the commutator, and will then bed themselves accurately into position. Care should be taken after doing this to blow away all carbon dust in just the same way as the copper dust was removed from the commutator when it was cleaned, as carbon, like copper, is a conductor of electricity, and might give rise to serious short circuits.

If sparking is accompanied by chattering or squealing of the brushes it is very probable that there is something wrong with the tension of the springs, which bear the brushes down onto the commutator, and it is advisable to try regulating these. It is important that the pressure should be kept just sufficiently light to ensure a firm, gentle pressure. Anything like heavy bearing means that the brushes wear out rapidly, there is excessive friction and heating, and a streak of carbon dust deposits on the commutator, and before long a flash-over occurs owing to the thick accumulation of carbon. The holders should allow the brushes to slide fairly easily, so that there is no chance of the carbons sticking up out of contact with the commutator, but at the same time they should not be loose enough to allow the brushes to wriggle, as otherwise it is impossible to keep a good bearing surface. Put in other words, it is necessary that the brushes should be exactly of the proper size for their brush holders. Spring tension can always be adjusted, if the carbon brushes slide easily, to a very great degree of nicety. No definite rule can be given as to the exact pressure which should be placed on the brushes, as this varies with the exact quality of the brushes and the amount of work to be done. It is better, however, to err on the light side rather than to give heavy bearing. A good deal of trouble sometimes happens if the contact between the brush and its holder is bad, as the current finds it difficult to get across from the brush to the holder, and heats the brush up unduly. This heat is then communicated to the commutator, with the result that before long sparking and arcing take place, to the detriment of the dynamo.

Supposing that everything had been done as described above to secure good bedding, an even surface to the commutator, careful spring adjustment and good contact, and sparking still continues, it is now necessary to turn attention to the position of the brushes with relation to the commutator and the poles of the machine. First of all it may be said that on most dynamos the brush should be of just sufficient width to cover slightly over two segments or bars of the commutator unless the number of bars is very great indeed per pole of the machine, in which case it may be necessary to cover three bars. It is not useful, however, to cover too many bars of the commutator at once, because when the brush covers two adjacent bars current can flow from one bar through the winding connected to it, round the next bar and then through the brush itself, completing its path and set up a local current which warms up the bars and windings uselessly. Too large brush width is not therefore advisable. At the same time the brush should not be made too narrow, because it is found that the current in a winding does not die down and reverse its direction instantaneously, but takes a little time in doing it, and this time is absorbed by the interval required to pass, say, two bars under the brush width. All this is a question of experiment, and the engineer who is confronted with a bad case of sparking should make tests for himself as to the right width of contact of the brushes with the commutator, always bearing in mind that in order to avoid overheating of the brush itself the area of contact must not be reduced unduly.

If the sparking appears to be about equal on all the sets of brushes around the commutator, it is very likely that while the dynamo has been running the brush rocker has become slightly displaced, and the brushes are therefore not in the best position for collecting the current. The best way of testing this is to rock the carrier backwards and forwards slightly while the dynamo is running under load and noting carefully whether the sparking increases or decreases as it is rocked. Care must be taken not to let the motion of the commutator drag the brushes forward too far, as otherwise a bad flash-over will occur owing to the dynamo loosing its exciting current. With care, however, it is easy to rock the brushes backwards and forwards until the point of least sparking is found. When this is done the rocker should be thoroughly and permanently clamped into this position. In some of the older dynamos it will be found that this position varies with the amount of current that the dynamo is giving out. At light load the position may be different by a 1/4 inch or 1/2 inch round the circumference of the dynamo to that occupied when the dynamo is working on full load and overload, and therefore the main ammeter on the switchboard must be watched and the position of the brushes altered in accordance with it. The careless attendant will probably cause a good deal of damage by neglecting to rock the brushes in accordance with the load if the machine is of the type where such alteration is necessary. In more modern machines, however, this is not so important, as they are designed with stiffer fields, and where they are subjected to very heavy and sudden overloads auxiliary poles are put in the magnetic circuit, known as inter-poles, for the purpose of correcting the twisting or distortion of the magnetic field, which happens when a heavy load is put onto the dynamo. In the interpole dynamo this distortion is corrected automatically, and there is not the same necessity to rock the brushes.

It may be, however, that the sparking occurs principally on one or two sets of brushes, and in this case it is probable that this particular set of brushes is wrongly set with relation to the rest. In order to test this, the best way is to take a long strip of paper and pass it round the commutator. Then mark on the paper with a piece of pencil the position of the front edge of each of the sets of brushes. Then take the strip of paper out and with a foot rule measure the distance between each of the marks. If all of these are exactly equal it follows that the spacing of the brushes is equal round the commutator, but if there is any difference there is one set of brushes out with respect to the others, and before satisfactory sparkless running can be obtained this irregularity must be corrected. In cases where the brush holders are set on a slant and not radial, the irregularity is probably caused by unequal lengths of brushes, and the only way to get the thing right is to file down the brushes until the spacing is correct. It may, however, happen that the brush rocker itself is at fault, and the spacing must then be corrected by a mechanical alteration, which may in some cases be a very difficult matter.

All the above is written on the assumption that the dynamo has only been called upon to do its fair share of work. In many instances, however, a ship's dynamo has been badly overloaded, more especially in view of the fact that it has been placed in a hot engine room, where it was naturally prone to warm up considerably and develop sparking tendencies. Most dynamos have plates on them showing the number of amperes and the pressure in volts at which they are normally supposed to work, and when this is the case it is an easy matter to compare the amperes with the indication of the main switchboard ammeter. If it is found that the dynamo is consistently working at a larger amperage than its proper value, it is unfair to expect that it will do anything less but spark, and this should be taken as an indication that the work should be eased off as far as possible. Again, the temperature of the engine room may be so high that it is unfair for electrical machinery to be asked to stand it at all, and ventilation should, therefore, be effected. Sometimes, owing to overloads and overheating, the insulation of the armature has become charred and the solder in the connections between the windings and the commutator has run and melted. The very least that can happen then will be considerable sparking, and a ship should always carry a spare armature for the main dynamo in case of trouble of this sort. Finally, it is necessary, especially on machines that have very little clearance between the pole pieces and the armature, to see that the bearings are kept in good condition. If the armature is allowed to drop with relation to the field, the magnetism upon which the generation of the electric current depends becomes distorted from its usual symmetrical distribution around the armature, with the result that one part of the armature may be trying to develop a great deal more current than the other half. The inevitable result of this will be sparking, which cannot be cured until the armature is restored to its central position with respect to the fields.

The above notes cover a few of the more important and likely causes for sparking in the main dynamo, and it is hoped that they will be of use to marine men who have to handle an electrical installation on board ship. A great deal more might be written on this and kindred subjects, but the limitations of space prevent too much detail being entered into at the present time. It may, however, be possible to return to the subject at a later date. Victor White.

London.

Steam Pipe Troubles

The material chosen for most steam pipes is still in many cases copper, although much has been written about the danger connected with the application of copper steam pipes with brazed flanges, and although many accidents show the necessity of departing somewhat from the common practice in this respect. No doubt copper was originally selected for steam pipes on account of its non-liability to corrosion and on account of its great ductility. It is often assumed that in bending pipes the axis of the saddle of the pipe does not lengthen, and that the material at the throat of the pipe becomes compressed to an amount about equal to the expansion on the back of the bend. This is not the case. As a matter of fact, the compression of the material is not very great, and the pipe expands by bending not only at the back of the bend but also on the sides, and, if it is remembered that the thinning of the metal must be proportional to the extension, it will be found that a pipe which has to be bent should be at least one gage thicker than required for the allowable pressure, and in many cases this is scarcely sufficient. Often the larger steam pipes are bound around with wire, while some firms put iron bands around the pipes every few inches. Such practices show that many engineers look upon copper with a certain amount of distrust.

When main steam pipes have to be made of copper, they should always be fitted with an automatic stop valve on the boiler, which will shut off the flow of steam to the engines if the pipe bursts. There are many such stop valves which are not entirely trustworthy, but some good ones are obtainable. A boiler explosion will always be realized as a serious matter, and therefore the dimensions of the safety valve are controlled by law. But why does not the law also require the application of automatic stop valves when copper steam pipes are applied? No doubt more men are killed by the bursting of copper pipes than by actual boiler explosions.

Brazed flanges are seldom trustworthy; the working of the pipes causes the spelter to become brittle, so that they will crack in the flange. For larger steam pipes the flanges are riveted to the pipes, which is a good practice, but the joint should be diagonal and not chain riveted, as with the latter method too much material in the pipe is drilled away, and the strength of the pipe is too much diminished. In fact, this has frequently been the cause of fractured pipes.

Steel is often used for steam pipes, and in such cases the flanges are threaded on the pipes, as shown in Fig. 1, or the whole pipe is made from the solid shaft, as shown in Fig. 2. In the latter case the hole is often bored eccentrically to provide for the bends. Steel is much stronger than copper for withstanding the pressure. Its thickness is more equal than that of cold-drawn copper pipes. Its strength is not diminished by the steam pressure, and its coefficient of expansion is less, but this latter property does not allow smaller bends, as the steel is much stiffer than copper, so that the flanges of the valves must be very strong, and especially well ribbed to the body and fastened with strong bolts. For long pipes the application of stuffing-boxes for expansion is necessary, but this is also the case with copper steam pipes. Steel pipes are often expanded in the steel flanges in the same manner as boiler tubes are expanded in the tube plates. Grooves are turned in the flange, as indicated in Fig. 3, and the hole at A is bored about 3/32 inch wider than at B. This manner of flange attachment is very efficient.

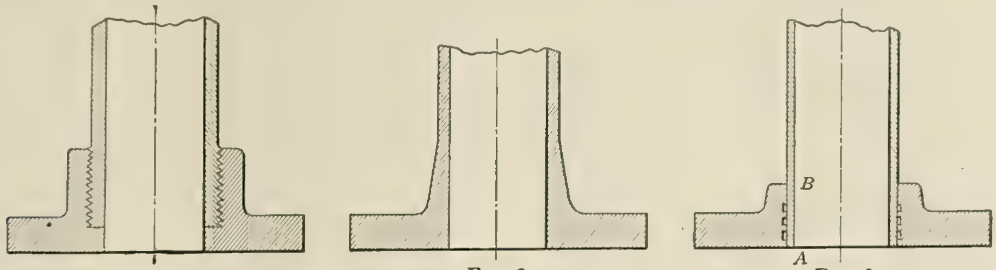


FIG. 1 FIG. 2 FIG. 3

FLANGES FOR STEAM PIPES

Copper pipes are also expanded in the steel flanges, and for circulating, waste and other water services cast iron flanges are used.

In one case on board a steamship the main steam pipes had to be made of copper, as no other material was allowed. As the engine builders had had several accidents with copper pipes they considered it necessary to place on each of the two boilers an automatic stop valve, as shown in Fig. 4. The valve was especially constructed for this case, as shown in the illustration. At A a small pipe 1 inch diameter is connected, leading steam from a small valve on the boiler. This is first opened, and by this means the engine is warmed up. When the pressure in the pipe is the same as that in the boiler the main valve is opened and the small one shut. When steam is on and the engine is running it is impossible for the spindle to become burned in the stuffing-box, as the valve and the spindle are always moving up and down a small amount. The spring must be so regulated as not to close when the engine is racing. Should the steam pipe burst the velocity of the steam will be

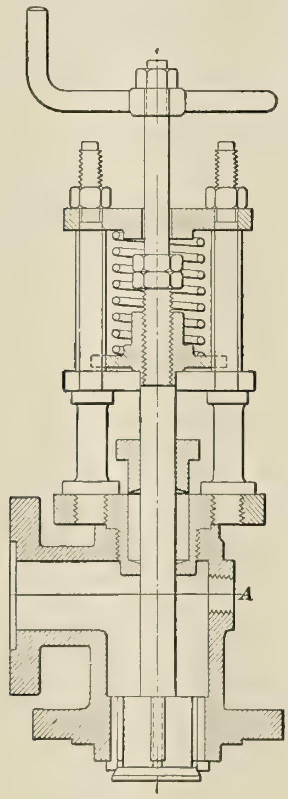


FIG. 4

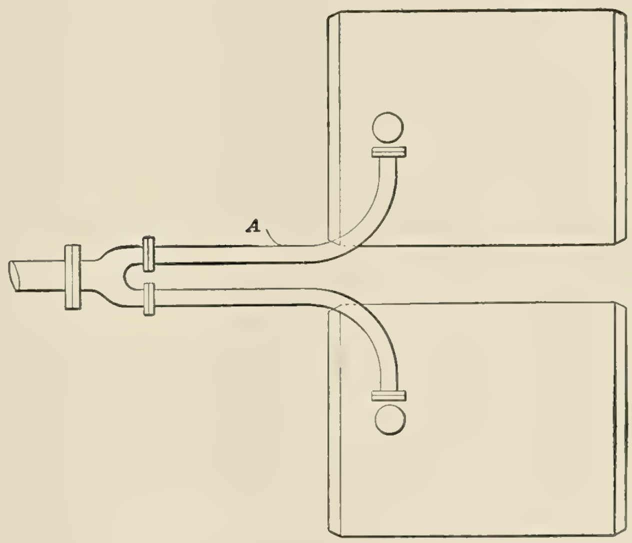


FIG. 5

so great that the pressure in the pipe will be less than the boiler pressure, so that the valve closes immediately. The steam pipes of this engine were expanded in the steel flanges, which at the beginning were perfectly steam-tight, but after a time they became so leaky that they had to be altered. The pipes were taken off and steel rings hammered into the pipe. These steel rings were then expanded in the pipe and the pipe was put back into place again. Since that time they have given no further trouble.

Some time later one of the pipes from the boiler burst, and the engine stopped. The engineer found in pipe *A*, Fig. 5, a burst seam 4 inches long. The automatic stop valves had performed their duty perfectly, and no doubt had saved the lives of the men in the engine room and stokehold. From this time on the engineers and firemen who had at first considered the valves as superfluous and troublesome were very anxious, and took special care to keep them in good order. They were not

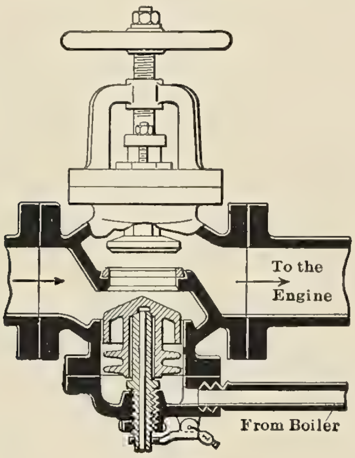


FIG. 6

very good automatic stop valves, but better ones are on the market, as, for instance, the one shown in Fig. 6. In this valve the steam flows in the direction of the arrow. When a steam pipe bursts the piece, *A*, will rise, forced up by the great velocity of the steam, and the pressure will be less on top of this piece than on the under side. The hole in the piece *A*, which leads to the atmosphere, allows the piece to be held down. The piece *A* may be put in place again by means of a lever and hand-wheel on the outside.

In any case, where copper steam pipes are used, an automatic stop valve is necessary, and it is unwise to do without them. It makes little difference what material is used for the steam pipe, an automatic stop valve is not out of place, and frequently where least expected it will save both lives and property.—D. K. in *The Boiler Maker*.

Graphite in Boilers

On one of the largest steamship lines operating from New York boiler graphite had been used for some time with very good results, until some one persuaded the engineers on one of the vessels to remove the zinc plates from the boilers on one particular trip. As soon as this vessel came into port, after a six months' trip, the boilers were found to be in very bad shape on account of serious pitting and corrosion. Previous to this trip the use of graphite in connection with the zinc plates had been found very satisfactory, as might be expected, because the zinc plates would offset any galvanic action which might be set up in the water used on these sea-going steamships, and also because the graphite would protect the boiler plates by dislodging any scale which might be deposited on them.

At the end of this particular trip the engineers were naturally at a loss to understand whether the excessive pitting and corrosion was due in any way to the use of graphite in the boilers, but investigations by experts seem to indicate that galvanic action was the cause of corrosion rather than graphite, as tests have shown that the presence of ten times as much graphite as is ordinarily used in boilers causes no unexpected increase in the rate of corrosion. In general, however, the manufacturers of boiler graphite recommend the use of either zinc plates or soda in boilers with the graphite to offset any tendency to corrosion.

Most engineers realize that the action of graphite in a boiler is not chemical but purely mechanical. Its use to overcome the danger and losses from scale formation is effective not because the graphite dissolves the scale or attacks the metal, but because the particles of graphite simply work into the minute cracks existing in any scale which has formed, and thus gradually penetrate between the scale and the metal, so that the scale is loosened from the metal and may be removed from the boiler with little trouble. Once old scale is removed from the boiler, the continued use of graphite means that it will be intermixed with any new scale which forms, rendering it soft and easily swept out instead of forming a hard scale on the metal. In other words, the boiler graphite forms a thin, slippery film over the boiler plates, protecting them from the action of the acids in the water and associates itself with the sediment which is formed, thus preventing the formation of hard scale and keeping the solid residue thrown down by the evaporation of the water in such a soft condition that it can be easily ejected from the boiler by blowing off.

It is sometimes the custom whenever the boilers are cleaned either to rub thoroughly graphite into all the water surfaces of the shell and tubes, or to put several pounds of graphite in the water and allow it to settle on the surfaces. It is found that much less scale will adhere to parts of the boiler coated with the graphite, and the scale that does form may be more easily removed than from uncoated surfaces. Different kinds of graphite are available for this purpose, and various manufacturers make positive claims for the superiority of the different kinds of graphite, although most of them are admitted to be beneficial to a certain degree. At any rate, a good form of graphite is rarely found detrimental to a boiler, although boiler troubles are often attributed to its use which really are caused by some other circumstance entirely immaterial to the use of the graphite. Water Tender.

New York.

For Trade Press Efficiency.—President H. M. Swetland, of the Federation of Trade Press Associations in the United States, announces that the programme has been completed for the eighth annual convention at the Hotel Astor, New York, Sept. 18 to 20. Acceptances are in hand from over sixty speakers of national reputation in the manufacturing, selling, advertising and publishing fields. There will be fifty 10-minute addresses at the Editorial, Circulation, Advertising and Publishing Symposiums on vital questions affecting all those who have dealings with the business press of America. Other features of the convention will be an exhibit of successful class, technical and trade journal advertising campaigns; a big business meeting, at which will be told the inside stories of the big trade paper publishing successes, and an inspirational mass-meeting, with addresses by representative business and professional men on subjects of live interest to editors, publishers and advertisers. All the regular sessions of the convention will be open, but tickets must be secured for the inspirational mass-meeting. These may be obtained from any member of the Federation, or from W. H. Ukers, chairman of the committee on arrangements, 79 Wall street, New York.

Marine Articles in the Engineering Press

Fire Extinguishers for Ships' Use.—By Naval Constructor Henry Williams, U. S. N. The recent adoption of fuel oil for naval vessels has augmented in a new direction the menace of fire, and, consequently, fire extinguishing apparatus capable of dealing with the dangers occasioned by the presence of fuel oil and fuel gasoline (petrol) must be provided. The subject of fire extinguishers is therefore taken up in a most comprehensive manner, every possible type of fire extinguisher being considered, beginning with water, sand, hand grenades, dry powder extinguishers, and then taking up the chemical fire extinguishers, heavy gas extinguishers, carbon tetrachloride extinguishers and the foam extinguishers, describing in detail the various kinds of apparatus, the methods of using and the results obtainable in so far as they have been shown by practice. 10 illustrations. 6,500 words.—*Journal of the American Society of Naval Engineers,* February.

The Motor Ship in Service.—The countless rumors to the effect that the large Diesel-engined motor ships are continually encountering serious troubles have led the writer to investigate the records of the principal motor ships since entering regular service. Such investigations disclosed the fact that most of the rumors are unfounded, and that the vessels are performing their regular service for the most part uninterrupted and with conspicuous success. Where troubles are experienced they are usually of a minor character and detract little from the value of this type of propulsion. The records investigated comprise practically all the large motor ships in service, and the information obtained is sufficient to show that any suggestion of general unsatisfactory operation of oil engine-driven vessels is entirely without real foundation. As a matter of fact, the success attained has been up to expectations, and the majority of the ship owners state that the commercial aspect of the vessels has been particularly pleasing. 2,600 words.—*The Motor Ship and Motor Boat,* June 26.

Scientific Ship Designing.—By Rear Admiral Casper F. Goodrich, U. S. N. This article, while primarily a review of the book by Sir Reginald Custance, R. N., entitled "Ship of the Line in Battle," gives some interesting comments on the subject under discussion. The author heartily recommends the book as something which every naval officer interested in new designs should read and carefully digest. It is not a history of armored ships, but a careful analysis of actions between them and between ships and fortifications made from the standpoint of strategy as well as of tactics, with a view to determining that relation between the military qualities of the fighting ship which is justified by history. The theorems which Sir Reginald draws and the problems he proposes are as follows: In a sea fight the object is at all ranges, and in a given time to strike blows greater in number than those received. Each blow must be effective but not unnecessarily powerful, since the use of a gun heavier than is necessary means a reduction in the number of guns carried, and therefore in the number of blows struck. The armaments of each ship should be sufficient, but not more than sufficient to do the work, as otherwise power would be wasted and her destruction would involve the loss of an excessive proportion of the total fleet. In his attempts to prove the above theses, Sir Reginald challenges the efficiency of the all-big-gun ship which has met with such general approval, and suggests that warship designers should not be hasty in rejecting the composite armament characteristic in the fighting ship which was developed through a century of naval warfare. By adhering strictly to the all-big-gun ship that well-balanced proportion between the important characteristics which history has always approved is destroyed, and it is suggested that methods of design be revised and the lessons taught by history be more thoroughly taken to heart. 2,700 words.—*United States Naval Institute Proceedings,* June.

White Star Liner Ceramic.—The *Ceramic,* built by Harland & Wolff, Ltd., for the Australian service of the White Star Line, is 674 feet 9 inches long over all, 655 feet long between perpendiculars, 69 feet 5 inches extreme breadth, 48 feet depth to upper deck, about 9,000 indicated horsepower, with a gross tonnage of 18,500. There are seven steel decks and twelve transverse watertight bulkheads carried to the upper deck, besides a cellular double bottom extending throughout the length of the vessel. Thirteen large insulated compartments are provided for the carriage of perishable cargo, comprising three holds and ten 'tween decks of a total capacity of over 310,000 cubic feet. The 'tween decks, in addition to the usual arrangement of brine grids, are fitted with air return and delivery trunks for the circulation of cold water at about 34 degrees for the carriage of fruit, etc. The refrigerating engines and accessories are located on the orlop deck on each side of the reciprocating engine room. The engines consist of two Hall's horizontal duplex CO_2 machines, each of which contains two complete units capable of independent working, so that actually four refrigerating units are provided. Accommodations are provided for 600 passengers ordinarily, with arrangements for a possible extension for a further 220 passengers. The propelling machinery for driving the triple screws consists of two sets of reciprocating engines driving the wing propellers and one low-pressure turbine driving the center propeller. The reciprocating engines have cylinders 26½, 42, 47½ and 47½ inches diameter by 4 feet 3 inches stroke, using steam at 215 pounds pressure. The turbine is of the Parsons type, designed to operate in the ahead direction only and uses the exhaust steam from the reciprocating engines. Steam is supplied by six double-ended boilers, 15 feet 6 inches diameter by 19 feet long, working under natural draft. The electric plant consists of three main engines and dynamos, supplied by W. H. Allen, Son & Company, Ltd., each having a capacity of 74 kilowatts at 100 volts. In addition, there is one 75-kilowatt Lawrence-Scott generator, driven by a four-cylinder Diesel oil engine, manufactured by Burmeister & Wain, at Glasgow. This is situated in a separate compartment on the upper deck level above the waterline at the after end of the ship, forming a source of supply for electric light and power independent of the main generating engines in case of emergency. A complete system of ventilation is installed, consisting of seventeen powerful Sirocco electrically-driven fans. 7 photographs. 2 plates. 5,500 words. —*Shipbuilding and Shipping Record,* July 3.

More Ships than Ever Before.—By Edward Neville Vose. Figures are quoted from Lloyd's Register of Shipping showing that the world's equipment for ocean transportation is now increasing at a more rapid pace than ever before in the history of maritime commerce. The immediate cause of this remarkable activity in shipbuilding is attributed to the fact that ship owners for the last two or three years have been making very handsome profits, which in turn is due to several causes, such as the enormous development of the world's commerce on account of both the increase in manufacturing and the exploitation and development of many portions of the world where hitherto the exports and imports have been very small. Other reasons for the unprecedented growth of shipping are the vast migration of the races from the overcrowded East to the fertile lands in the West, the vast expansion of tourist traffic and also the approaching completion of the Panama Canal. The immediate effect of the latter cannot be prophesied with any degree of certainty, but the author points out the amount of tonnage which is available for service through the Panama Canal from practically every maritime country. The impression is gained from the author's treatment of this question that most of the large steamship companies in England, Germany, France, Italy, Sweden and Japan are eagerly seeking opportunities to extend their traffic through the canal, while steamship companies of the United States, although their combined tonnage is the second largest in the world, are doing very little toward the development of Panama traffic. There is no question but that the volume of shipbuilding now in the course of completion will make this year the record shipbuilding year in practically every country in the world except the United States. The blame for the inactivity in the United States is attributed by the author to its obsolete navigation laws. 28 illustrations. 5,500 words.—*The World's Work,* August.

The French Battleship Courbet.—In comparing the battleship *Courbet,* built at the Government Dockyard at Lorient, with the English battleship *Orion,* the main details of the new French war vessel are disclosed. The principal dimensions are: Length, 546 feet; breadth, 88½ feet; draft, 29 feet, for a displacement of 23,100 tons with 900 tons of fuel on board. The machinery consists of Normand boilers and Parsons turbines, designed for 28,000 horsepower. The main armament consists of twelve 12-inch guns arranged in six barbettes. The secondary armament includes twenty-two 5.5-inch guns and four 3-pounders. The main armor belt is 11 inches thick, reduced to 7 inches at the ends and surmounted by a strake 7 inches thick amidships. 3 illustrations. 570 words.—*Engineering,* July 11.

Steam Trials of the Chilian Torpedo Boat Destroyer Almirante Lynch.—The Chilian torpedo boat destroyer *Almirante Lynch* is the first of six similar vessels ordered from Messrs. J. Samuel White & Company, Ltd., of East Cowes, Isle of Wight. They are 330 feet long over all, 320 feet long on the waterline, with a molded breadth of 32 feet 6 inches and a molded depth of 21 feet. The designed draft approved for the trial was 9 feet 9 inches, at which the vessel displaced 1,530 tons. Propulsion is by Parsons turbines, aggregating 30,000 horsepower, mounted on three shafts. On the full power trial over the measured mile at Skelmorlie on the Clyde, the designed horsepower was exceeded, the mean speed being 31.7 knots and on the six hours' run 31.85 knots. 750 words.—*Engineering,* July 18.

Hydraulic Dredging on the Upper Mississippi River.—By R. Monroe. To obtain a depth of 6 feet at low water on the Mississippi River, between St. Paul, Minn., and the mouth of the Missouri River, the Government is confining the low water flow in the river by closing side channels and building wing dams from the shore into the stream to the proposed edge of the low water channel. The width of this channel varies from 300 feet at St. Paul to 1,400 feet at the mouth of the Missouri River. This work, together with the removal of an immense amount of sand and silt brought into the Mississippi from side streams, forms a wide field for the use of the hydraulic dredge. Three 18-inch dredges were completed last year by the United States, and there are now in this district eight dredges, all of which are essentially similar, the principal difference being the size of the boiler and engine details. Each dredge consists of a centrifugal sand pump connected by rope drive to a steam engine, a swinging suction pipe supported by a catamaran, and about 500 feet of discharge pipe supported by pontoons. The main details of the dredging plants in operation in this district are given, including the first cost of the dredge and pipe line, also the exact cost of operation, the dredging capacity and the cost per cubic yard dredged. The costs, capacities and dredging data are of exceptional value, being complete in every respect. 2 illustrations. 3,000 words.—*Engineering News,* July 24.

The Story of the Anchor Line.—The Anchor Line is more closely identified with the city of Glasgow and the shipbuilding industry of the Clyde than any other line flying the British flag. It was started by a firm of ship brokers and merchants, and the first vessels operated under the Anchor flag were sailing vessels, which were sent out on ventures to Bombay and in the St. Lawrence trade. In 1854 the Anchor Line opened a steamship service between Glasgow and Lisbon. The Lisbon branch of the trade soon expanded into the Mediterranean, and to meet this expansion three more vessels were required. Meanwhile, the vessels operated in the Canadian service were converted into steamships, and during the winter, when navigation on the St. Lawrence was closed, these vessels were sent to New York, which within a few years became the main transatlantic port of the line. All this happened before the early sixties, but beginning with 1864 the expansion of the line to the Mediterranean, the North Sea, and finally after the opening of the Suez Canal, to India, progressed rapidly. Direct Calcutta service was established in 1882. At the end of the nineteenth century new and larger vessels were placed in the Bombay, Calcutta and New York services, and in recent years an arrangement has been made by the Anchor Line with the Cunard Company for the New York service and with the Brocklebank Line for the Indian service, so that there is now a large measure of community of interests between these lines. The Anchor Line has built no less than eighteen new steamships of 118,000 gross tons since its conversion from a private undertaking, and with its new allies forms part of a large and important organization which is entirely under British management and control. 8 illustrations. 1,700 words.—*Marine Engineer and Naval Architect,* August.

The Norwegian-American Liners Kristianiafjord and Bergensfjord.—Messrs. Cammell, Laird & Company, Ltd., of Birkenhead, have built to the order of the Norwegian Shipping Company, Den Norske Amerikalinje, Christiania, the twin screw passenger and emigrant steamers *Kristianiafjord* and *Bergensfjord,* to be placed in regular service between Christiania and New York under subsidy from the Norwegian Government. The ships, of 11,000 gross tons and 17 knots speed, are 510 feet long between perpendiculars, 61 feet molded breadth, 40½ feet depth, molded to shelter deck, and 26 feet maximum draft. Subdivision of the hull is by a cellular double bottom and nine transverse watertight bulkheads. The construction of the hull and the accommodations for passengers are described in some detail, illustrated with drawings and photographs. 105 first class, 216 second class and 700 third class passengers are carried. Heating and ventilating is carried out on the thermo-tank system, there being twelve thermo-tanks on each vessel in addition to five exhaust fans for special purposes. The electricity is supplied by three 60-kilowatt dynamos. Lifeboat accommodations provide for all on board, the boats being stowed under double-acting Welin davits. Ten derricks, worked by ten 7-inch by 10-inch steam winches, are provided for handling cargo, together with a heavy derrick at the foremast. Propulsion is by two sets of quadruple expansion engines, designed to develop 8,500 indicated horsepower at 95 revolutions per minute. The cylinder diameters are 26, 37½, 53 and 75 inches, respectively, and the stroke 51 inches. Steam is supplied by eight single-ended boilers, 16 feet diameter by 11 feet 8 inches long, designed for 220 pounds working pressure and fitted with Howden's system of forced draft. 8 illustrations. 1,750 words.—*The Shipbuilder,* August.

New Books for the Marine Engineer's Library

Boilers and Boiler Works

Steam Boilers. By E. M. Shealy. Size, 6 by 9 inches. Pages, 356. Illustrations, 185. New York, 1912: McGraw-Hill Book Company. Price, $2.50 net.

The author of this book, who is an assistant professor of steam engineering at the University of Wisconsin, has had extensive experience in teaching this subject by correspondence in the Extension Division of the University. The book, therefore, is the result of well-matured plans to produce a suitable text for instruction by mail as developed through actual experience. As it is written primarily for correspondence students, it is intended particularly for the use of firemen and others who may be in responsible charge of boiler rooms. With this object in view the author has dealt very sparingly with the actual construction and calculations for strength of boilers. Only about thirty pages are devoted to this subject, as only the essential details and calculations are given. The first two chapters contain comprehensive descriptions of various types of boilers. Then follows the part devoted to boiler calculations, stays and staying. The remainder of the book is devoted to the discussion of heat and work, the properties of steam, evaporation, fuels, combustion, boiler settings, piping, fittings and accessories, as well as the inspection, care and testing of boilers.

Laying Out for Boiler Makers and Sheet Metal Workers. Second Edition. Size, 10 by 13 inches. Pages, 305. Illustrations, over 600. New York, 1913: Aldrich Publishing Company. Price, $5.

One of the most important operations in a boiler shop is the laying out of the various parts of boilers, stacks, tanks and other sheet metal work. This work requires considerable technical knowledge involving a thorough understanding of the elementary principles of geometry, mechanics and elementary mathematics, although a complete mastery of such subjects is not essential. The most common layouts require the development of cylindrical, conical and other curved surfaces, as well as the determination of the intersection of these surfaces when the article to be manufactured is in the shape of an elbow or irregular transition piece. In this book the practical application of the principles involved in the laying out of such work is explained by numerous examples, including an explanation of the various cal ulations which are necessary to determine the proper size of the different parts of the boilers, tanks, etc.

Most of the material in the book is reprinted from *The Boiler Maker,* and the first edition, which contained eight chapters covering the subject of laying out, triangulation, how to lay out a tubular boiler, how to lay out a locomotive boiler, how to lay out a Scotch boiler, repairing locomotive and other types of boilers, the lay out and construction of steel stacks and miscellaneous problems, has been amplified in the second edition by the addition of 113 new pages fully ilustrated, a large part of which, including forty-four new laying out problems, is a continuation of the last chapter in the first edition on Miscellaneous Problems. There are also two additional chapters, one on miscellaneous calculations showing how to figure the strength and efficiency of riveted joints, the area of circular segments and the cost of boiler construction, and a chapter on Tools for Boiler Makers and Their Uses, in which can be found many practical hints as to the proper way to use the ordinary tools and to operate the more complicated machine tools.

This book is recommended as a valuable aid to anyone engaged in the layout and construction of boiler and heavy sheet-metal work, and especially to those who are seeking advancement in the boiler-making trade, as promotion to the position of layerout is one of the most important steps in the boiler maker's climb to the top of his profession.

Wireless Telegraphy

Manual of Wireless Telegraphy and Telephony. Third edition. By A. Frederick Collins. Size, 4⅞ by 7⅜ inches. Pages, 300. Illustrations, 129. New York, 1913: John Wiley & Sons. London: Chapman & Hall, Ltd. Price, $1.50.

A Handbook of Wireless Telegraphy. By James Erskine-Murray, D. Sc. Fourth edition. Size, 5½ by 8¼ inches. Pages, 442. Ilustrations, 200. New York, 1913: D. Appleton & Company. Price, $3.00 net.

The Year Book of Wireless Telegraphy and Telephony, 1913. Size, 5½ by 8¼ inches. Pages, 564. Numerous illustrations. London, 1913: Marconi Press Agency, Ltd. Price, 2/6 net.

These three books, while quite different in character, cover the field of wireless telegraphy and telephony very comprehensively. The first, which is a revised and enlarged edition of a book which has met with much favor, is a practical treatise of the subject giving detailed and explicit instructions for wiring the various types of sending and receiving apparatus now in general use, the adjustment of the instruments, tuning and syntonizing the circuits, testing the devices and finally explaining the management of ship and shore stations.

The second book, while a somewhat lengthy treatise on the subject of wireless telegraphy, does not pretend to be an encyclopedia, nor, on the other hand, a simple exposition of the subject for the benefit of the lay mind. Rather it is intended for the use of those who have some familiarity with both the theory and practice of wireless telegraphy and who can, therefore, comprehend a more technical book to better advantage. There are twenty-one chapters in the book, many of the chapters being devoted to a special part of the apparatus, or a special system of wireless telegraphy. The theory of transmission is gone into quite extensively, and, in fact, no subject is dismissed until its various relations to the science have been thoroughly discussed. A valuable feature will be found in the final chapter, which contains data which are difficult to find elsewhere, dealing with the inductance of helices, capacity of condensers of various forms and sizes, resistance of various conductors to high frequency currents and similar numerical quantities required in the design of radio-telegraphic apparatus.

The third book under review is a new departure, and is issued for the first time this year. The aim of the publishers has been to produce a year book which will be indispensable to those concerned in wireless telegraphy whether technically or commercially, and which will contain information sufficient to make the immense variety of matters relating to the subject intelligible to the general public. The Year Book opens with a calendar which is followed by a concise chronological record of the progress of wireless telegraphy since 1896. Next follows the administrative section, which is considered by the publishers as one of the most important parts of the book, as it contains the London Convention of 1912, the laws and regulations of the principle countries concerning wireless telegraphy, all carefully prepared in English; then there is a complete list of land and ship stations of the world, with their call letters, ranges, wave lengths and the nature of the service, hours of opening and changes set out in a convenient form which makes reference easy. A technical section is provided containing articles contributed by some of the leading experts in this field.

ENGINEERING SPECIALTIES

100 Horsepower Nlseco Diesel Engine

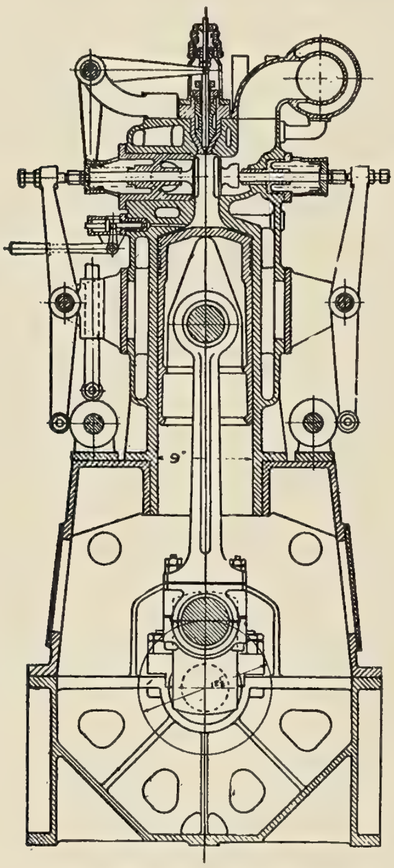
To meet the demand for a simple, durable, reliable Diesel engine of approximately 100 horsepower for use in yachts, fishing boats, small tugs, etc., the New London Ship & Engine Company, Groton, Conn., has developed the four-cycle, 100-120 horsepower marine engine illustrated, and has produced it at a cost which compares very favorably with that of gasolene (petrol) engines suitable for the same service, an achievement that has been considered by engineers abroad as wellnigh impossible. The engine has four working cylinders, a 9-inch bore and a 12½-inch stroke, with the usual arrangement of inlet, exhaust and fuel valves. Cylinders numbers 2 and 3 are arranged for air starting. The engine is not reversible, as for power of this size it is more practicable and convenient to use a reverse clutch, following the usual practice with gasolene engines in motorboats. The air compressors are of the usual two-stage type, and are driven by one of the cranks on the main crankshaft. Another very novel feature is in connection with the fuel-supply system, which has been patented by the New London Ship & Engine Company. Only one pump is used, and this is made so durable and strong that there is little chance of disarrangement and no opportunity for trouble by operators changing adjustments, since there are no adjustments to change. Circulating water is furnished by means of a centrifugal pump. Mechanical force feed oilers are used. The engine is very economical with lubricating oil.

The first time the engine was started, when placed on the test stand, it immediately developed 115 horsepower. It has since developed as high as 130 horsepower, but these are overloads, and it should not normally be run at more than 100 horsepower, for which it was designed. The fuel consumption varies from .5 to .6 pound per horsepower hour, depending upon the load and other conditions. The engine has been used for driving the machinery in one of the shops of the New London Ship & Engine Company, where the load varies from 60 to 120 horsepower. The governor consists of centrifugal weights in the flywheel, and controls the engine very satisfactorily under the great variations of load in the machine shop, due to the use of electric-driven air compressors and of some very large machine tools. The same type of governor will be supplied on all engines, as when the clutch is used a governor is very desirable on an engine as large as this.

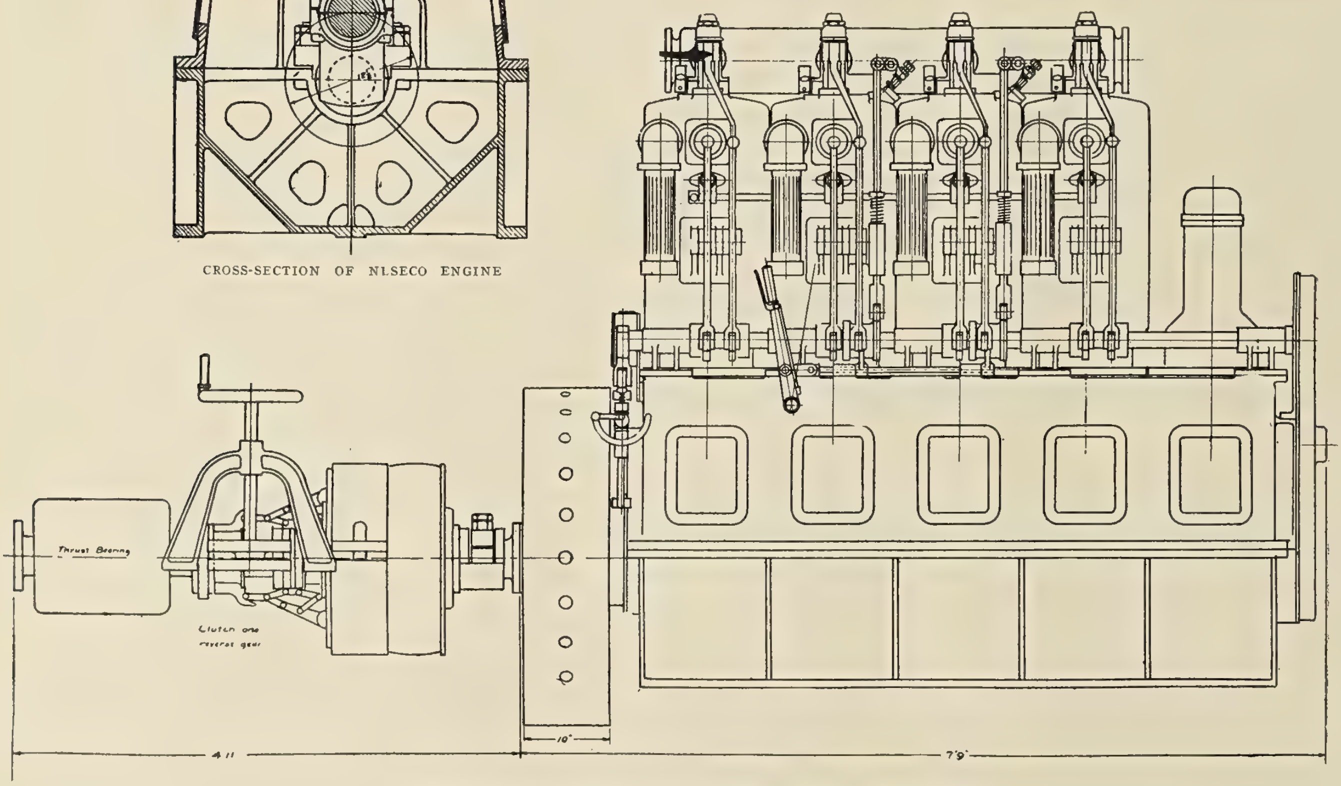
This type of engine is also built in six-cylinder units, developing from 150 to 180 horsepower. Both the four-cylinder and the six-cylinder engines, with cylinders of this size, run at 350 revolutions per minute.

The operation of the engine is easily understood by men who were previously familiar only with gasoline (petrol) engines, and is so very simple that there is little danger of its getting out of order in service. The particular engine in question was erected by a gasoline (petrol) engineer who had never before seen a Diesel engine, and has since been operated entirely by him with most satisfactory results.

While this type of engine was designed primarily for marine use, especially for Pacific Coast work, it is also suitable for

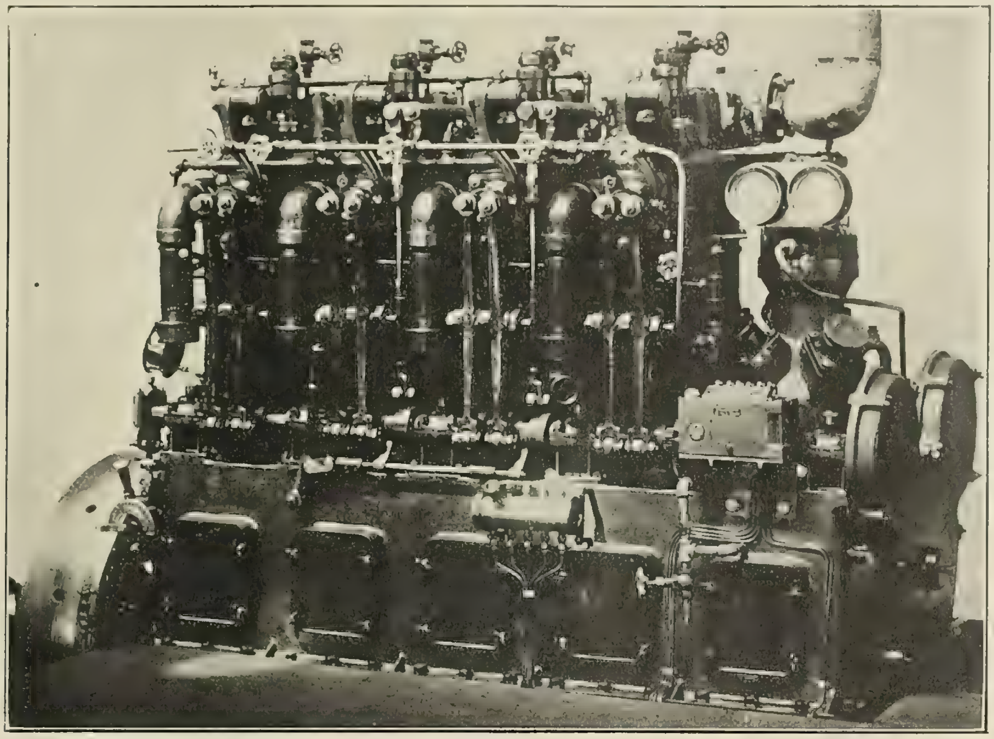


CROSS-SECTION OF NLSECO ENGINE



100-120 HORSEPOWER NLSECO HEAVY OIL ENGINE, SHOWING CLUTCH use on board ship for driving auxiliary machinery, and for small lighting plants on shore.

The builders also propose to build a larger size engine of 50 horsepower per cylinder for similar uses.



NLSECO HEAVY MARINE ENGINE

Portable Pump Operated from Incandescent Lamp Socket

A portable electrically driven pump, with a capacity of 100 gallons per minute, is made by the Edwards Manufacturing Co., of Cincinnati, Ohio. The weight of the pump, including the motor, does not exceed 125 pounds. It is claimed by the makers that it will operate regularly up to its maximum capacity on current from an incandescent lamp socket. The working parts of the Edwards electro-portable bilge pump, made of brass, operate on ball bearings and are self-lubricating. There are no valves to take care of, and no possibility of freezing, the water automatically draining out as soon as the current is shut off. The motor is fitted to the exhaust tube, and sustains its own weight. It is claimed by the makers that this pump needs virtually no attention. There is no bearing on the shaft, and, consequently, no wear on the parts. It can be installed in working order instantly, and is quite simple to operate.

EDWARDS PORTABLE PUMP

Another electrically driven bilge pump is built by the Edwards Manufacturing Co. for heavy work. This pump has a capacity of 500 gallons per minute. The construction is similar to that of the smaller pump. Two of these heavy duty pumps have been installed by the Louisville and Cincinnati Packet Co., and are said to be giving perfect satisfaction.

Rivet Sets for Pneumatic Hammers

One of the difficulties experienced by the manufacturer of machine-turned sets is the general lack of uniformity in the steel itself, either in chemical composition or in the heat treatment. . Forged rivet sets overcome this difficulty. They have made some wonderful records for service and endurance and are becoming more popular every day. The Chicago Pneumatic Tool Company, Chicago, Ill., has installed up-to-date furnaces and power hammers and are turning them out in great quantities. With the aid of electric pyrometers they are able to preserve uniformity in heat treatment, thus placing entirely within their control one of the vital features of their construction. The general demand for rivet sets is for those cupped for button and conical heads, and which they have designated as standard. But they are prepared to furnish them in all shapes and sizes for special work.

Improved Flow Meter

To meet the requirements of a strong mechanical meter, which can be used not only as a test instrument, but as a stationary meter for the continuous measurements of either liquids, gases or vapors, the instrument illustrated has been brought out by the General Electric Company, Schenectady, N. Y. An exterior view of the meter is shown in Fig. 1, and the mechanism in Fig. 2.

The body of the flow meter consists of an iron casting cored out so as to form one leg of a U-tube and a reservoir for mercury, the outer leg of the U-tube being formed by a pipe which opens into the reservoir. The pressure on the surface of the mercury varies with the rate of flow of the fluid being measured, as will be explained later.

A float *O* rests on the surface of the column of mercury in the body of the meter and rises and falls with the corresponding changes in its elevation. The float is geared by rack *P*

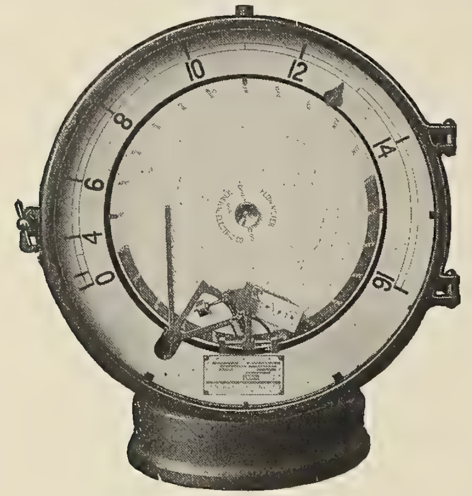


FIG. 1

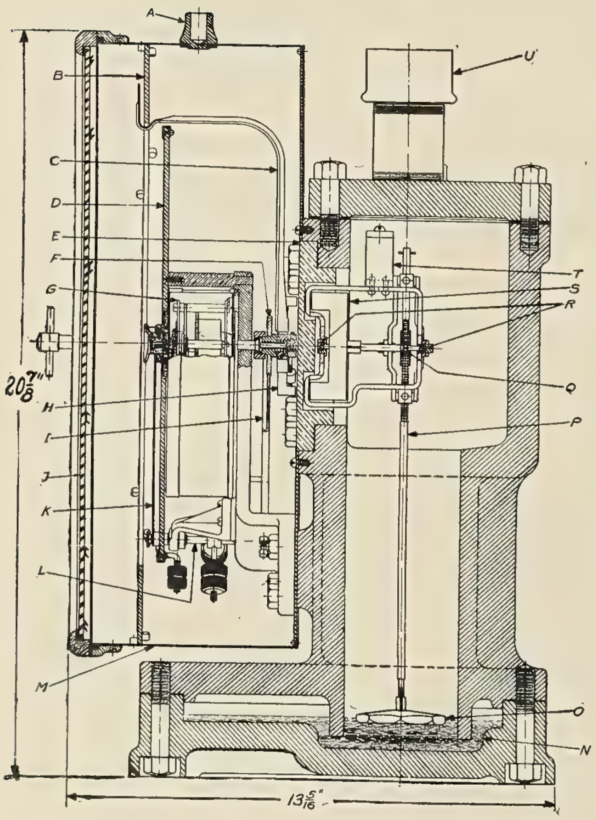


FIG. 2

and pinion *Q* to a horizontal shaft *R*, which carries a permanent U-shaped magnet *S*. The poles of this magnet face a copper cap *E*, which closes an opening into the meter body. The remaining parts of the meter's mechanism are mounted on the outside of the cap. A shaft, parallel to the one on which the magnet inside the body is mounted, carries a smaller magnet *H*, whose poles are opposite those of the larger magnet, this arrangement tending to transmit motion through the cap without piercing it with a shaft, and thus the difficulty of packing such an entrance to prevent leakage is avoided. As the poles facing one another are of opposite polarity, the magnetic flux binds them together, so that a movement of the magnet inside the body involves a corresponding movement of the one outside, the latter moving the indicating needle *C* and the recording pen *K* through suitable mechanism.

The pressure which moves the column of mercury in the U-tube is obtained, for pipes two inches and greater in di-

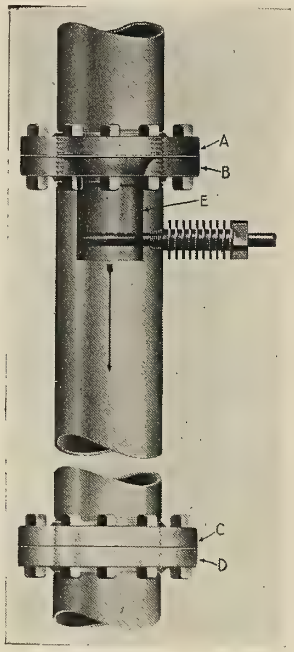


FIG. 3

ameter, by inserting a modified form of Pitot tube, termed a "nozzle plug" (shown in Fig. 3), directly into the pipe line. This can be done without disturbing the piping, except where it is desired to increase the rate of flow at the point of metering, in which case a special pipe reducer (*E* in Fig. 3) is provided. This reducer is made of brass, and has a long throat with rounded entrance terminating in a flange. The flange is inserted between the pipe flanges and is held in place in the same manner as a gasket. A special nozzle plug is supplied with the pipe reducer.

The nozzle plug is a tube with two separate conduits in it, each conduit having a set of openings, the two sets being on diametrically opposite sides of the tube. Those on the side of the tube facing the flow are called the leading openings, while those on the opposite side are called the trailing openings.

The flow against the leading openings in the nozzle plug sets up a pressure in the leading conduit which equals the static pressure plus a pressure due to the velocity head. The flow past the trailing openings causes a suction which lowers the pressure in the trailing conduit. As these two conduits are connected to the U-tube by ¼-inch pipes, the column of mercury is affected by this unbalanced pressure, causing a movement of the float. The leading set of openings in the nozzle plug extends approximately across the pipe diametrically, so as to make the velocity pressure transmitted to the meter the mean velocity rather than that at a single point in the pipe.

The chart on which the pen records are made is rotated by a clockwork at a suitable speed. The recording pen sweeps the chart radially, and the resulting curve shows the rate of flow at any time during the chart cycle.

The integrating device consists of a stationary flow-rate planimeter driven by the chart paper. The angular position of the planimeter wheel is determined by a cam connected to the shaft of the recording pen and moving with this pen. The planimeter dials read in arbitrary units, which, multiplied by a constant furnished with the meter, gives the flow in the desired unit. This device is extremely simple, and there is practically no danger of its getting out of adjustment.

For pipes less than two inches in diameter, an orifice tube, which is a brass pipe tapered internally from both ends so as to form a restricted opening at the middle of the tube, is provided, and it must be incorporated in the pipe line. One leg of the U-tube is connected to the orifice tube near its end, and the other leg to its middle point, where the greater velocity at the orifice will give a reduced pressure in the pipe leading to the U-tube.

To meet the requirements of the different classes of service and the various conditions met with, the meter can be made up in four different ways: first, as a recording or curve-drawing instrument; second, with both indicating scale and recording chart; third, with recording chart and integrating dials; fourth, with indicating scale, recording chart and integrating dials, an exterior view of which is shown in Fig. 1.

Some of the large companies have found that flow meters pay for themselves in a short time. With their use the record of the performance of the apparatus shows whether it is operating at the greatest efficiency or not. Surprising conditions have been brought to light by their use, showing at once how indispensable they are. A flow meter on each boiler of a battery running in multiple on the same header shows just what each is doing, and so permits adjusting the operation of the units so that each will carry its full share of the load. They also indicate immediately whether the load has increased or the steaming rate of the boilers decreased, in case the steam pressure begins to drop. Moreover, from the graphic record of steam pressure, it is possible to determine whether the method of firing can be made more efficient or not. In a big plant, the use of flow meters makes it possible to segregate the costs of the steam, water, etc., so that each department can be charged with its share of the costs of these, and a study of the feed-water chart will determine the rate at which the feed water should be supplied to secure the highest degree of efficiency.

"DBS" Spur Reducing Gear

David Brown & Sons (Hudd.), Ltd., Lockwood, Huddersfield, manufacture reduction gearing for the transmission of power for various purposes. For spur or double helical gears to be satisfactory, however, they must be properly mounted with good, substantial bearings, as close as possible to the

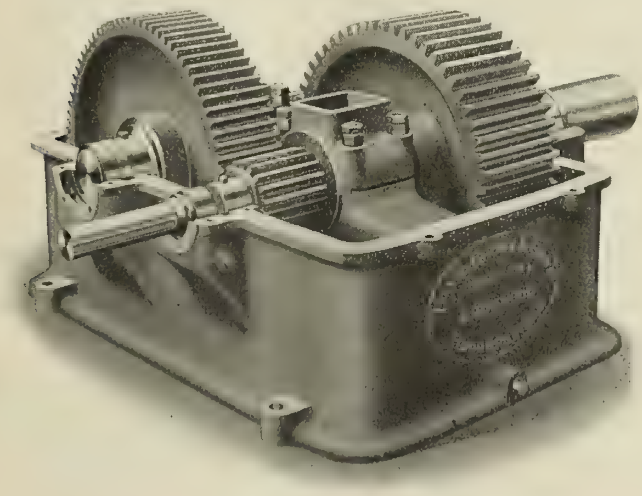


FIG. 1.—"DBS" STANDARD DOUBLE REDUCTION GEAR

gears, and, on account of the strains tending to separate the two shafts due to the load being transmitted, it is also essential for the bearings to be rigidly housed in the case, otherwise the center distance is liable to alter, or the shafts themselves become out of parallel. Neglect of these points results in rapidly wearing, noisy and unsatisfactory gears. For this reason, David Brown & Sons recommend, whenever possible, the standard single or double reduction gears, such as shown in Fig. 1, which have been specially designed to withstand hard usage. The reduction cases are provided with either spur or

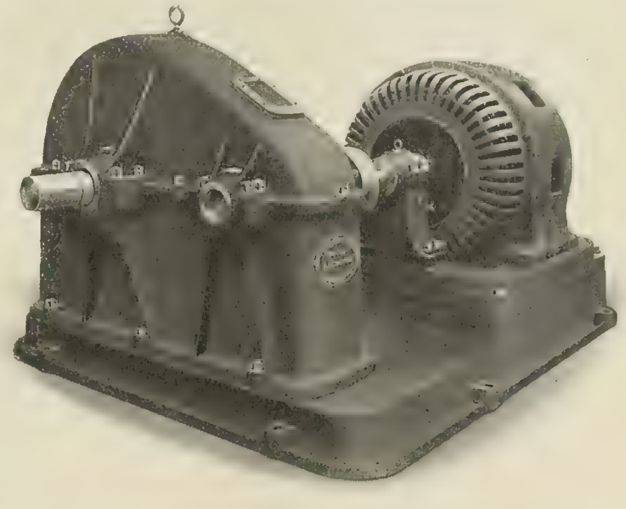


FIG. 2.—28-IN. SINGLE SPUR REDUCER, COUPLED TO 200 HORSEPOWER MOTOR

double helical gearing, according to the speed at which they have to run and the class of work for which they are intended. The cases are complete in themselves, and only require to be coupled to the motive power at one end and to the machine to be driven at the other. This style of mounting also insures efficient lubrication and the exclusion of all dust and dirt from the gears. A typical set is illustrated in Fig. 2 coupled to a 200-horsepower motor.

Obituary

Capt. Henry C. Daggett, for more than thirty years in command of vessels of the Savannah Line, died recently at his home in Brooklyn at the age of seventy. When only nineteen years old, Captain Daggett was given his first command of a full-rigged ship, and since that time he has been one of the best-known captains in coastwise service, being a familiar figure at the ports of the Atlantic seabord of the United States.

J. Merton Taylor, president of the Taylor Instrument Companies, Rochester, N. Y., died July 31 following a short illness. Mr. Taylor was born in Rochester fifty-seven years ago, and was a son of the late George Taylor, founder of the Taylor Instrument Companies. He was associated with this concern throughout his life, becoming president in 1910. He was an example of the highest type of business man, and as such was respected and held in highest esteem in the business world.

Vernon H. Brown, for many years agent of the Cunard Steamship Company, died at his home in New York, Aug. 5, at the age of eighty-one. Mr. Brown was in the service of the Cunard Line for nearly thirty years, and was the first American to hold the post of manager. His first experience in the shipping business was as an apprentice in the firm of Sampson & Tappan, owners of a famous fleet of clippers in the East India trade. When he became of age, Mr. Brown went into business with his father, forming the firm of Vernon Brown & Son, of Boston, engaging in the East India trade. Later Mr. Brown came to New York and established the firm of Vernon H. Brown & Company, which continued in the shipping business until a few years ago. He was interested in many important business enterprises as a director and trustee.

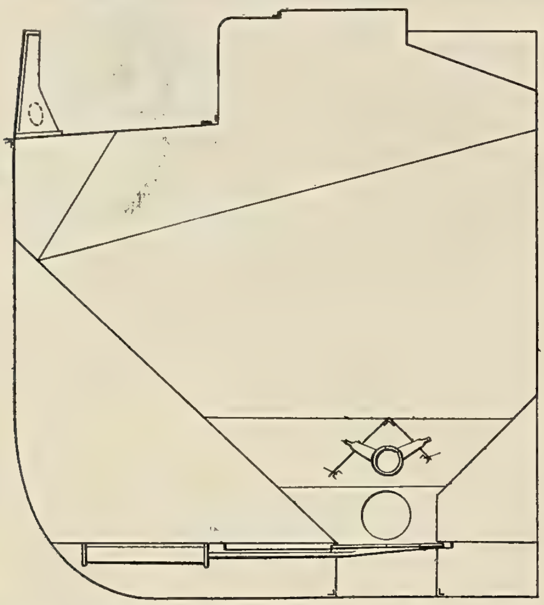
SELECTED MARINE PATENTS

The publication in this column of a patent specification does not necessarily imply editorial commendation.

American patents compiled by Delbert H. Decker, Esq., registered patent attorney, Loan & Trust Building, Washington, D. C.

1,063,284. DREDGE-HOPPER. JOHN REID, OF NEW YORK, N. Y.

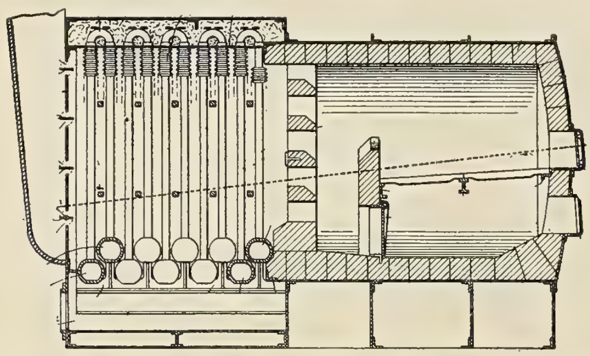
Claim 1.—A dredge hopper, comprising sloping and perpendicular walls leading to a trough portion at the bottom thereof, a protecting roof for said trough portion and discharge openings through the skin of



the vessel at intervals from said trough, and a water pipe arranged under said protecting roof and having spraying nozzles extending into the hopper proper and adapted to keep the dredged material moving. Five claims.

1,064,250. MARINE SUPERHEATER. JOHN PRIMROSE, OF NEW YORK, AND GODFREY HARTER, OF DANSVILLE, NEW YORK, ASSIGNORS TO POWER SPECIALTY COMPANY, OF NEW YORK, N. Y., A CORPORATION OF NEW YORK.

Claim 1.—A stack in a marine superheater, the combination of a superheating chamber, a steam superheater therein, a furnace of cylindrical cross section having its rear end connected to the superheating



chamber to discharge hot gases of combustion thereinto, a wall between the superheater and the stack having a plurality of apertures therein and means to close part or all of said apertures whereby a uniform flow of gases through the superheater may be obtained. Nine claims.

1,063,832. MEANS FOR LOADING SHIPS. BERNARD REIVER, OF PHILADELPHIA, PENN.

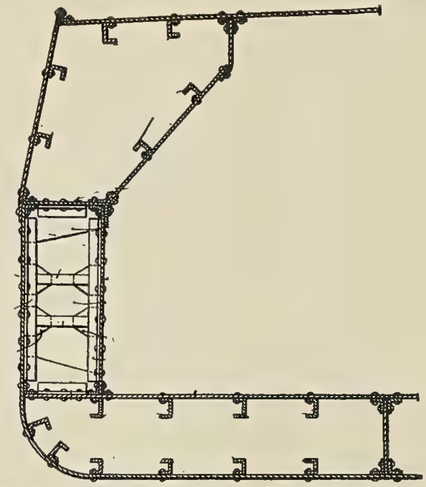
Claim 1.—In means for loading and unloading vessels, a tube connecting two vessels, a lashing cable for connecting the two vessels passing through the tube, and a second tube arranged within the first mentioned tube and adapted to have the load passed therethrough. Two claims.

1,063,804. MEANS FOR CLEANING SHIPS' HULLS. GUSTAV JULIUS KINDERMANN, OF WAYVILLE, SOUTH AUSTRALIA.

Claim 1.—A device for cleaning ships' hulls, comprising two spaced electric motors each inclosed in a casing, each casing being provided with an eye at the end, a pair of eyes on each side, and a spring buffer between each pair of eyes, a shaft between the motors and coupled thereto, a cleaning member mounted on the shaft to turn therewith, and cables attached to the eyes of each of the motors for securing the device to a ship's hull. Two claims.

1,065,549. SHIP. JOHN REID AND GEORGE SIMPSON, OF NEW YORK, N. Y.

Claim.—In combination, a top side ballast tank having a main framing therewithin formed of fore and aft channel irons, a bottom ballast tank having a main framing therewithin, formed of fore and aft channel irons, and buttress framing extending from said bottom ballast tank to said top side ballast tank and forming reinforcing pillar frames at

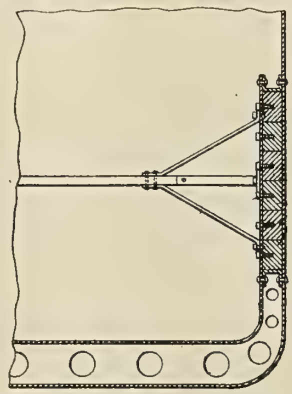


intervals throughout the length of the ship between said tanks, said buttresses being formed of vertical channel irons extending between brackets connected to said ballast tanks by angle irons and braces crossing between the verticals intermediate of the length thereof. One claim.

British patents compiled by G. F. Redfern & Company, chartered patent agents and engineers, 15 South street, Finsbury, E. C., and 10 Gray's Inn Place, W. C., London.

13,114. IMPROVEMENTS IN THE CONSTRUCTION OF NAVIGABLE VESSELS. J. MACNAB OF ISLINGTON, MIDDLESEX.

Claim.—This invention relates to a navigable vessel provided with a double cellular bottom and consists in extending the inner bottom above the waterline substantially parallel with the inside of the hull and inserting between the adjacent faces of the hull and the extended



portion of the inner bottom at some distance above and below the waterline, wooden battens which form a buffer-belt or fender, for protecting the ship when in collision, etc. The battens may be extended around the inside of the hull and an inner skin, which forms a downward extension of the upward extension of the inner bottom, may be provided.

4,729. DEVICE FOR LIFE SAVING IN CONNECTION WITH SUBMARINES. H. BEACH, OF "METHLEY," TOTTERIDGE LANE, WHETSTONE, MIDDLESEX.

This invention relates to submarine vessels having a detachable float, which, in the event of the vessel being accidentally sunk, can be released from a receptacle in which it is normally located and which it seals, and thereby caused to carry to the surface of the water a pipe by which air can be conveyed to the interior of the vessel. The invention comprises the provision of apertures in the float through whch water can pass to the interior of the receptacle to allow the float to rise and the adaptation of the catches by which the float is secured to close such apertures when they engage the float and to open the apertures when they are withdrawn from the float to release it.

10,990. IMPROVEMENTS RELATING TO THE CONSTRUCTION OF SHIPS. A. E. SCOTT, C. E., OF WEST HAMPSTEAD, MIDDLESEX.

Claim.—For the purpose of strength and lightness the bulkheads of zig-zag, angled or corrugated section, are stiffened at or about one-third of their unsupported depth from the base by doubling strake, or a plate or bar bent to conform to and riveted to the face of the bulkhead, this stiffening member serving to strengthen the bulkhead against buckling at the level of the center of pressure due to the full head of water dammed by the bulkhead. The member may be of any thickness and depth that may be required to afford the necessary strength to a bulkhead built of zig-zag or corrugated plates of a given thickness.

International Marine Engineering

Published Monthly by ALDRICH PUBLISHING CO.

17 BATTERY PLACE, NEW YORK — 31 CHRISTOPHER ST., LONDON, E. C.

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Edited by H. H. Brown, A. M. Inst. N. A.
Member Soc. N. A. and M. E.

Vol. XVIII — OCTOBER, 1913 — No. 10

Trial Runs of the Pacific Liner Congress

The twin screw passenger and freight steamer *Congress*,* built for the Pacific Coast Company by the New York Shipbuilding Company, Camden, N. J., from designs by G. W. Dickie, naval architect and marine engineer, San Francisco, left the shipbuilding company's dock at Camden at 10 A. M. on Saturday, July 17, for her official trials. As the vessel was under charter to load a general cargo for San Francisco, it was found impracticable to load her to a mean draft of 22 feet 6 inches, as required by the specifications, so the trials were made with the vessel drawing 25 feet 4 inches aft and 15 feet 5 inches forward, with a displacement of 8,360 tons.

The Delaware Breakwater was reached late at night and the vessel was anchored until daylight, when a few hours were spent adjusting compasses. A progressive trial over the measured mile was then carried out, consisting of five double runs beginning at 10 knots and ending at 16.5 knots, from the results of which the speed, power and revolution curves were plotted. A run at full speed was then made out to sea for six hours and back again at a mean speed of 16.5 knots.

FIG. 1.—TWIN SCREW PASSENGER AND FREIGHT STEAMER CONGRESS BUILT BY THE NEW YORK SHIPBUILDING COMPANY FOR THE PACIFIC COAST COMPANY

The *Congress* returned to the shipyard late on Sunday night,

* For description, see page 283, INTERNATIONAL MARINE ENGINEERING, July, 1913.

Fig. 2.—Second Class Lounge

Fig. 3.—First Class Stateroom and Bath

and on July 29 she was accepted by the owners and proceeded to the Port Richmond docks to take on a general cargo of 3,500 tons. The vessel then left Philadelphia with a mean draft of 27 feet 2 inches in fresh water, or 26 feet 4 inches in salt water, and began her long trip to the Pacific Coast, leaving the lightship at 10 A. M. Sunday morning, when the river pilot gave up charge to Captain H. C. Thomas, who is taking the ship around to San Francisco.

On the fourth day out the vessel touched at Trinidad to take on oil to replace the fuel burned en route. The four days' run to Trinidad gave ample opportunity to test the speed and power curves produced on the trials. At the start the revolutions were fixed by the curve for 12½ knots. It was found that the vessel exceeded that speed by from 6 to 9 knots a day, although the days were six or seven minutes short of the twenty-four hours, and the mean draft on trial was 19 feet

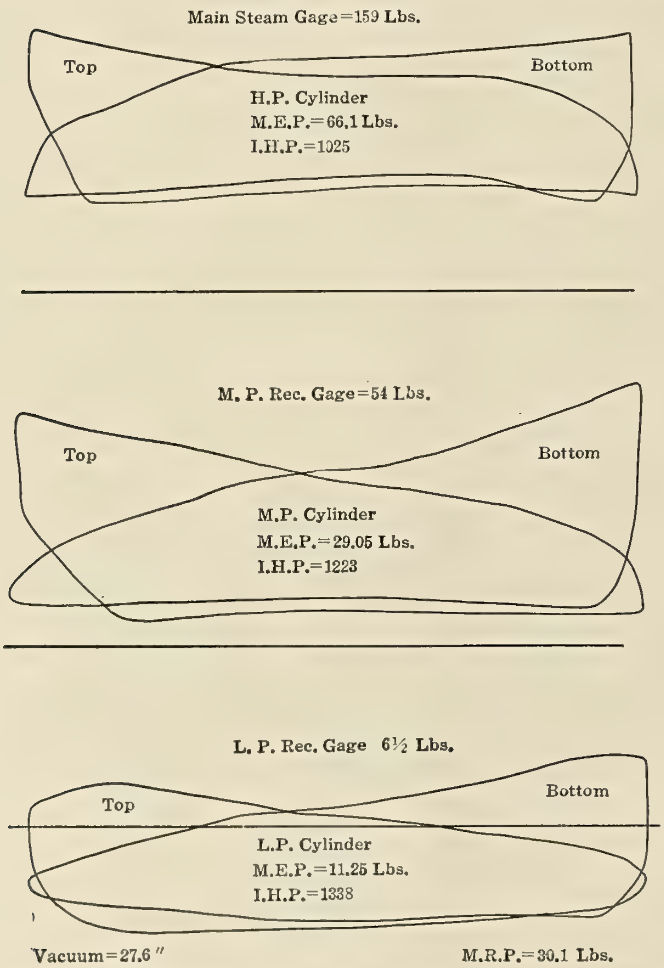


Fig. 4.—Indicator Cards from Port Engine at 91.92 R. P. M. Total Horsepower, 3586

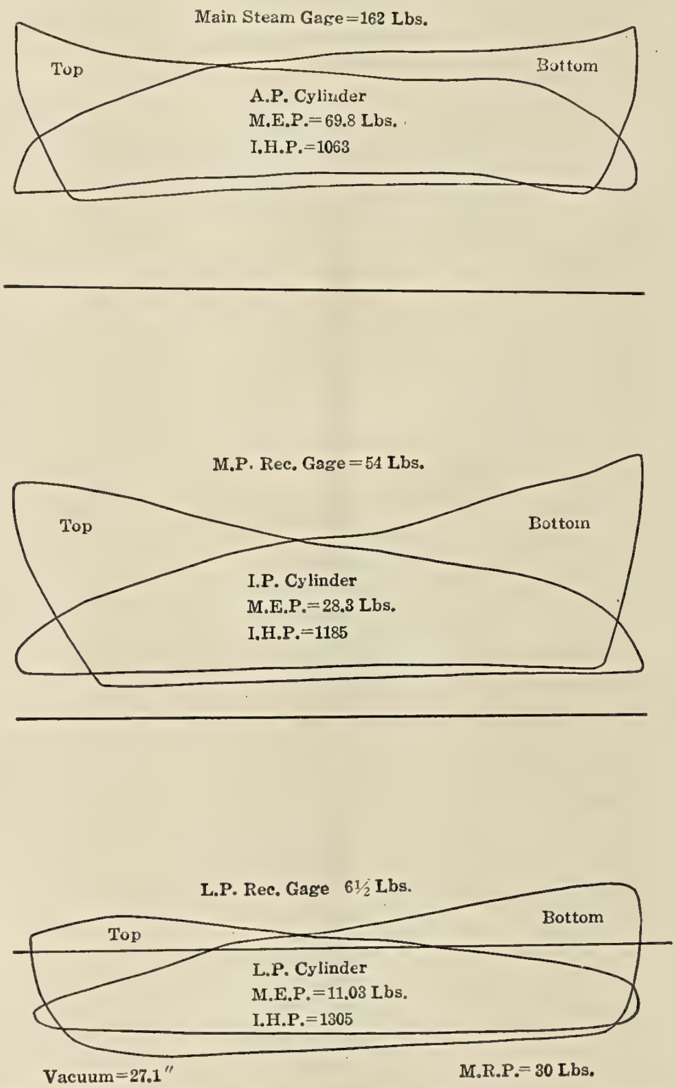


Fig. 5.—Indicator Cards from Starboard Engine at 91.93 R. P. M. Total Horsepower, 3553

FIG. 6.—FIRST CLASS DINING SALOON

FIG. 7.—BALL ROOM ON BOAT DECK

FIG. 8.—FIRST CLASS LOUNGE

FIG. 9.—FIRST CLASS SMOKING ROOM

10½ inches, while on the four days' run it was 26 feet 4 inches with about 3,000 tons more displacement.

The data obtained from the standardization trials are shown in Table I, while the speed, power and revolution curves are plotted in Fig. 10. Figs. 4 and 5 show a set of indicator cards (not full size) taken from the port and starboard engines respectively on the fifth run over the measured mile. At the time of the trials the sea was calm with a north wind blowing at the rate of four miles per hour. The weather was cloudy, and the temperature on deck 75 degrees Fahrenheit, with the barometer registering 29.84 inches.

The *Congress* is propelled by two sets of triple expansion

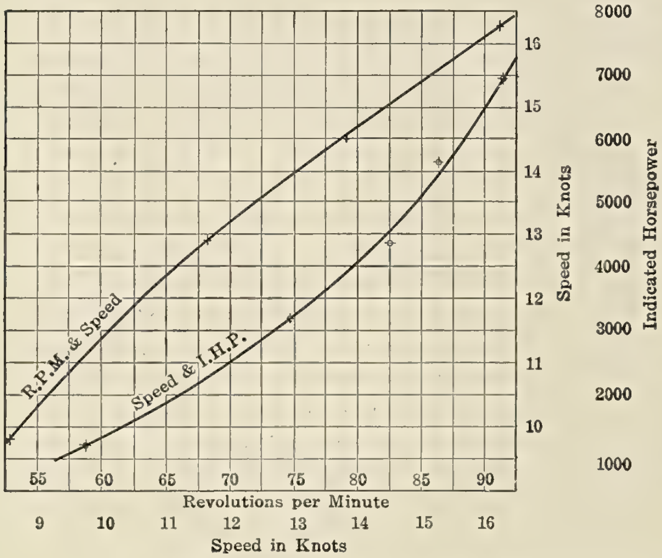


FIG. 10.—SPEED, POWER AND REVOLUTION CURVES

surface condensing engines with cylinders 28½, 46½ and 78 inches in diameter with a common stroke of 54 inches. The engines were designed to develop an indicated horsepower, collectively, of 7,500 at about 86 revolutions per minute, in order to give the ship a speed of 16½ knots. The main air pumps and the main feed and bilge pumps are driven off the main engines. The propellers are three-bladed with a diameter of 15 feet and a pitch as designed and held of 21 feet 7½ inches. The developed area of the three blades of each propeller is 77½ square feet and the projected area 59.6 square feet. The propellers are so constructed that the pitch is adjustable 12 inches either way. Steam is supplied by 10 single-ended marine boilers, 15 feet inside diameter and 11 feet 10 inches inside length, with a total heating surface of 22,116 square feet. They are constructed for a working pressure of 180 pounds per square inch under natural draft, and fired with oil fuel by means of the Dahl system of burners.

As the interior arrangements of this vessel are entirely new to the coasting trade, and as this large and finely appointed ship has been designed to meet the requirements of a rapidly growing business that bids fair to demand a type of coasting vessel that was not dreamed of twenty years ago, a few illustrations will serve to show far better than words the type of vessel that is coming within the reach of those who travel by sea on the Pacific Coast of the United States.

The first thing that interests the passenger who never misses a meal is the dining room. This room on the *Congress* is 75 feet long and 53 feet wide, and has 54 tables seating four persons each. The seats are arranged as a solid frame in polished mahogany, each surrounding a column encasing the steel deck pillars. The seats fold down and the seats and backs are upholstered in dark green leather. The floor in this room is of dreadnaught tiling. The tables at the sides are in alcoves which are formed by deep web frames. There are two 16-inch portholes in each alcove, making 42 in all. A window frame of prism glass covers the portholes, giving the appearance of large windows. These open for ventilation. Above the seats the room is finished in an ivory tint with parapan enamel, the roof being in flat white. Fig. 6 gives a very good idea of the attractiveness of this room.

The first class lounge has been designed to meet the requirements of the passenger who seeks an elegant and airy place to rest. This room is on the bridge deck and is 48 feet by 40 feet in size. There are three large bay windows on each side, between which the electrical heaters are worked into fireplaces. Fig. 8 gives a good idea of the style of this room, the green carpet and green upholstery making a fine contrast with the mahogany finish.

The first class smoking room (Fig. 9) is on the boat deck forward, and the second class smoking room on the bridge deck aft. Both of these rooms are large, airy and comfortable, and both are finished in quartered oak.

The captain's quarters, immediately forward of the first class smoking room, consist of a very handsome apartment

Table I.—Data from Standardization Trials of S. S. Congress over Delaware Breakwater Course, July 20, 1913.

No. of Run.	Direction.	Total Revs.	Mean Total Revs.	Average R. P. M.	Mean R. P. M.	Elapsed Time on Course in min.	Mean Speed.	I. H. P.	Mean I. H. P.	Pressure by Gage. Main Steam.	I. P. Rec.	L. P. Rec.	Vac. in Inches.
1	N	305 303	304	52.3 52.	52.6	5.83	9.76	590 607	1226	165 169	3 0	11 ins 11½ "	27.8 27.6
2	S	371 371	371	53 53		7.00		616 639		168 170	3 0	11 " 11½ "	27.6 27.6
3	N	291 289	290	68.16 67.7	68.2	4.27	12.95	1749 1369	3210	169 170	17 13	0 0	27.7 27.75
4	S	374 373	373½	68.6 68.4		5.458		1716 1587		168 169	16 13	0 0	27.8 27.7
5	N	304 304	304	78.61 78.61	78.9	3.867	14.5	2231 2123	4342	168 169	30 25		27.6 27.75
6	S	381 379	379	79.68 78.8		4.783		2216 2115		167 169	29 26		27.5 27.75
7	N	326 319	322½	86.4 84.52	85.5	3.773	15.25	2913 2648	5627	167 169	42 35	2 lbs 1½ "	27.3 27.75
8	S	380 371	375½	86.61 84.58		4.387		2967 2727		167 168	41 36	2 " 1½ "	27.1 27.75
9	N	328 326	327	91.92 91.36	91.3	3.567	16.30	3586 3553	6978	159 162	54 34	6½ " 6½ "	27.6 27.1
10	S	375 370	372½	91.6 90.4		4.092		3402 3415		153 156	50 50	6 " 6 "	27.6 27.0

en suite in mahogany. These rooms are directly under the bridge and are of unusual size, attractively arranged.

The second class passengers have been provided with comforts unknown to that class of travel on the Pacific Coast. The second class lounge, at the after end of the bridge deck, shown in Fig. 2, is one of the most attractive public rooms on the ship. The second class dining saloon on the upper deck is also a very handsome room. These rooms are in quartered oak.

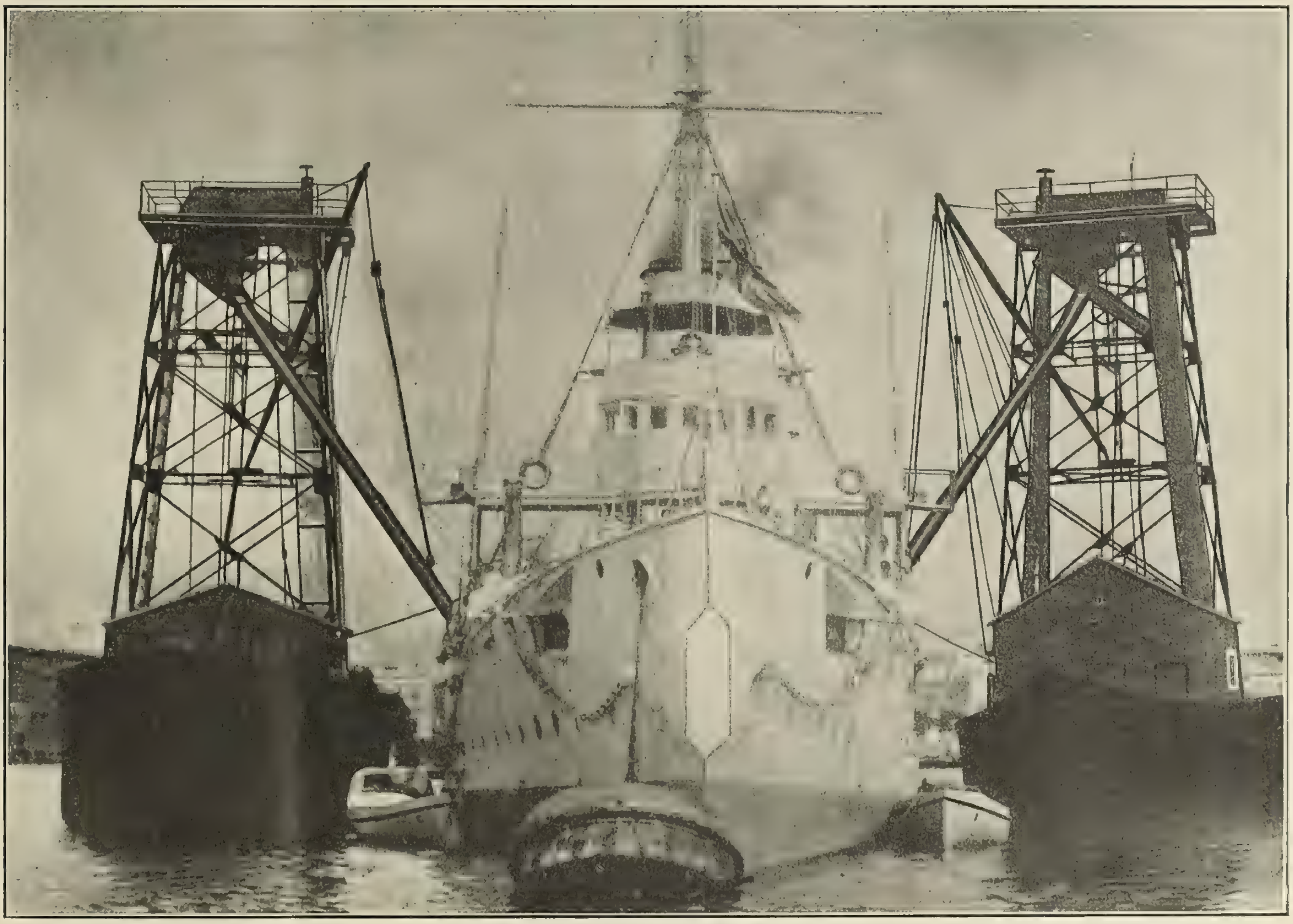
There are some very handsome staterooms on the *Congress*, a very good example of which is shown in Fig. 3. This room is one of a suite finished in bird's eye maple with blue draperies and upholstery. The deck lounges at the head of the stairs on the boat deck, which are finished in quartered oak with upholstery in red plush, are also a feature of this ship.

A very attractive feature of the *Congress*, especially on that part of her run south of Point Conception, where the water is smooth and the evenings balmy, is the ball room on the after end of the boat deck. The roof of this room is supported by girders, so that the entire floor space is available for dancing. Another feature of interest regarding the boat deck is the arrangement of the life boats and life rafts. There are 14 large lifeboats to carry 42 persons each and 14 life rafts with a capacity of 19 persons each stowed under them. All these are handled by Norton patent sheathed screw davits, and they are so arranged that much of the deck space is left free for the use of the passengers.

Whatever the success of this vessel may be, she illustrates the efforts being made to produce ships that are not only seaworthy and safe, but are of such a character as to discount all the discomforts of coastwise travel on the ocean.

Bunkering H. M. S. Melpomene

The Havana Coal Company, Havana, Cuba, has made itself independent of the crowd of unreliable laborers formerly required in coaling vessels by adopting coaling barges equipped by the Link-Belt Company, of Philadelphia, with machinery for handling run-of-mine coal at the rate of 125 to 150 tons per hour for each barge. The arrangement in each case includes two strong apron conveyors running the entire length of the barge under the storage space, receiving coal through Link-Belt under-cut gates, and delivering it to a Link-Belt gravity discharge elevator, which runs to a sufficient height to secure a proper angle of flow through a swivel spout leading to the different bunkers of the ship as desired. The barges can receive their supply of coal at the docks in relatively shallow water, and deliver to deep-draft vessels out in the harbor, in the manner shown by the accompanying view of two of the Havana Coal Company's barges bunkering H.M.S. *Melpomene*.



TWO OF THE HAVANA COAL COMPANY'S BARGES EQUIPPED WITH LINK-BELT COALING APPARATUS BUNKERING H. M. S. MELPOMENE

The use of these outfits greatly decreases the expense of handling the coal, besides saving much time for the vessel, and their rugged construction and great efficiency are consequently attracting the favorable attention of coaling companies in various parts of the world, as evidenced by a recent shipment to the Rapid Coaling Syndicate, Ltd., Liverpool.

United States Destroyer Trials.—The average speed of the destroyer *Cummings*, built by Bath Iron Works, during her 4-hour endurance test off Rockland, Me., Aug. 27, was 30.52 knots. The destroyer *Parker*, built by the Cramp Ship & Engine Company, Philadelphia, on an unofficial trial over the Delaware Breakwater course, attained a speed of 29.6 knots.

The Influence of Air Pumps on the Military Efficiency of Turbine-Driven Warships *

BY D. B. MORISON

This paper assumes a recognition of: (*a*) Military value of speed in a warship; (*b*) tactical value of reliability in production and maintenance of maximum speed, according to the requirements and expectations of the commanding officer.

In the equipment of a steam turbine installation there is no auxiliary engine which has a more important bearing on a warship's speed than the air pumps of the condensing plant. This importance arises because of the influence of vacuum on propelling power, and because it is air pump efficiency which, under given conditions, enables the condenser to produce the highest vacuum obtainable, and air pump sufficiency which enables such vacuum to be maintained when air beyond the normal quantity is present in the condensing system.

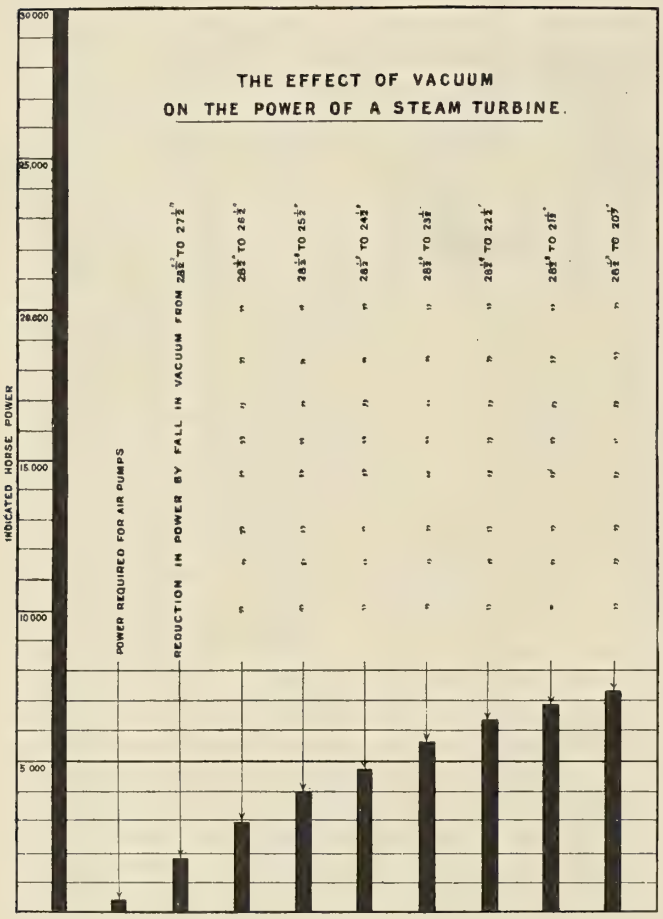


FIG. 1

The degree of vacuum at which any turbine will develop its maximum power with maximum economy depends on the design of the turbine, and the detail design is determined by the compromise best suited to any given range of conditions, such as temperature of sea water, weight, space occupied, etc. According to latest cruiser practice, a vacuum of 28½ inches is required at full power in sea water at 55 degrees, and, provided that the turbine is bladed to make adequate response in power to such a vacuum, then Fig. 1 shows the loss in power which results from a fall of vacuum.

The source of power is, of course, the boilers, and therefore the maximum power obtainable depends primarily on the quantity of steam which can at any time be generated. But if under conditions of maximum and constant generation of steam in the boilers the vacuum falls from 28½ inches to 27½ inches, then the immediate loss in power is about 6 percent, or say 1,800 indicated horsepower in a cruiser of 30,000 indicated horsepower. In warship practice the exhaust steam from all the auxiliary engines is discharged into a receiver, and at full power is maintained at 25 pounds pressure. Apart from its employment in an evaporator the heat in this steam can be utilized to the best thermal advantage in raising the temperature of the feed water, and the most advantageous use that can be made of any surplus is for power production in the low-pressure section of the main turbine. If, under full power conditions and at 28½ inches vacuum, sufficient exhaust steam is available to raise the temperature of the feed to a predetermined limit, then at 27½ inches vacuum there would be a surplus of such steam, because of the increased initial temperature of the condensate. If this surplus were utilized for power production in the low-pressure section of the main turbine the increase in power would be slightly under 1 percent. Assuming, as is generally the case, that for reasons of weight and space occupied there is no feed-heating apparatus in a warship, then this increase in condensate temperature due to the lower vacuum would probably raise the steam generating efficiency of the boiler by about 1½ percent. Therefore, even after adjusting the diagram, Fig. 1, to the most favorable conditions of working, the loss due to a fall of 1 inch of vacuum is still about 1,400 indicated horsepower for the same weight of fuel consumed, and about 20 tons of coal per day are wasted.

The effect on the power of a turbine of steam pressure at the entry, and of vacuum at the discharge, is of interest. If it were desired to lower the steam pressure at the entry to the turbine to a point which would correspond to the loss in power consequent on a fall in vacuum from 28½ inches to 26½ inches, it would be necessary to reduce such pressure from, say, 200 pounds to about 110 pounds, other things being equal. That is to say, the pressure of steam entering the turbine would have to be reduced about 90 pounds in order to cause a loss in power similar to that which results from an increase in condenser pressure of only 1 pound.

The alternative effect to loss of power by a fall in vacuum is an increase in the quantity of steam necessary for the development of a given power, thereby reducing the radius of action obtainable from a given weight of fuel. The broad question of vacuum on a turbine-driven warship is therefore one of great military importance.

The highest vacuum that any given condenser could maintain under given conditions would be realized if no air entered the condenser.* This airless state is impossible, as some air is always circulating through the system from the boiler to the boiler, and may at any time be augmented by insidious leakage through joints in the vacuum system.

The primary function of an air pump is to enble the condenser to maintain within itself the nearest approach possible to the condition that would prevail were the steam airless. In practice, therefore, the *minimum* capacity of an air pump is determined by the quantity of air in suspension and solution in the feed water as it enters the boiler, without provision for insidious leakage from joints, glands, rivets, bolts, cocks, valves and the like which are included within the vacuum system.

The effect of insidious air leakage on the action of an air pump may be realized to some extent by the fact that 1 cubic inch of air at atmospheric pressure, subject to its relative temperature when augmented by water vapor, will become in a condenser at 28½ inches vacuum about 50 cubic inches. From

*Abstract of a paper read before the Institution of Naval Architects, London, March 12, 1913.

* The writer has dealt at length with surface condenser efficiency in an article appearing in the current issue of the *Journal of American Naval Engineers*.

this it is obvious that if the designed capacity of an air pump provides for no air leakage beyond what enters the system with the steam, then any such leakage, no matter how small it may be, will cause a fall in vacuum, a loss in propelling power, and a reduction in the speed of the ship. An air pump of this basis capacity may be said to have no air margin.

In land practice the electrical engineer is never without a substantial air margin on a turbine condensing plant. He has learned from experience that, at times, no matter how carefully the plant may be manufactured and the joints made, air will leak into the vacuum system, and that it is generally a most difficult and tedious process to locate the leakage. If the pump has no air margin the vacuum falls, the cost of producing electrical energy rises and profits suffer. He knows that the only way of adequately providing against this loss is by the adoption of such proportions as will deal with air leakage contingencies.

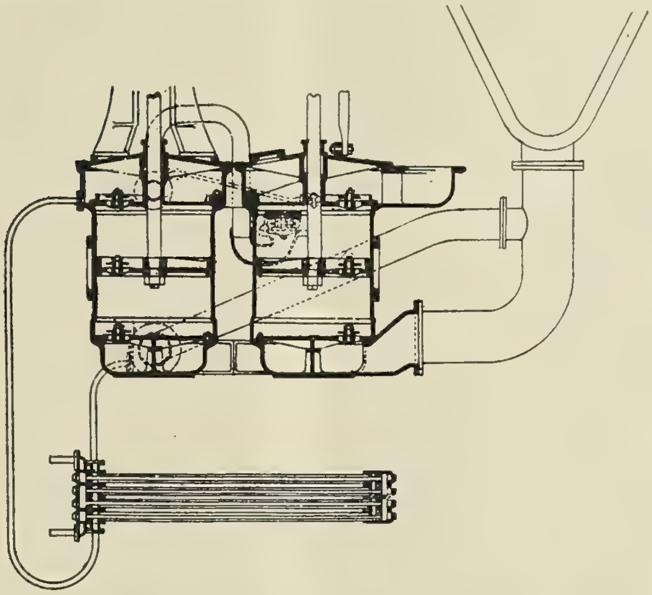


FIG. 2.—RECIPROCATING AIR PUMPS, WET AND DRY INTERDEPENDENT SYSTEM

A warship presents a somewhat different problem by reason of limitations of weight, space and economy of steam under varying load and conditions of service, the extremes being maximum power at full speed and harbor duty at rest. The only margins allowable in this problem of obtaining the greatest power from a given weight of machinery and a given quantity of fuel are those which are essential to efficiency and safety under the most severe conditions in actual warfare.

Compare, for instance, the conditions of the feed pumps with those of the air pumps on a warship and the relative consequences in the event of the breakdown, in action, of a feed pump and an air pump. If a feed pump breaks down entirely there is merely a temporary inconvenience, as ample provision is always made in the boiler feed system for such a contingency. In a military sense the consequences would be *nil,* as the speed of the ship would be unaffected. Not so with an air pump. Break down an air pump and the warship at once becomes a slower and less reliable unit, unable to respond to the speed expectations of her commanding officer, and in addition there are the mechanical risks due to the extra water load to be sustained by the other air pumps which may be available for parallel working.

Fortunately, the total mechanical breakdown of an air pump is a rare occurrence, but the danger, of course, is always present. Therefore, in view of the inevitable loss in propelling power from an accident, which would in many cases affect the vacuum system as a whole, and of the consequences which might result therefrom, a reasonably adequate factor of safety becomes imperative. Next in importance to a breakdown of the mechanism of an air pump comes its breakdown in adequacy of air-withdrawing capacity, should there be such a disturbance of the normal air-tightness as would cause the quantity of air to exceed that with which the air pump can deal without a drop in vacuum. It should be noted that although such a disturbance would generally affect only one section of the condensing plant, it would nevertheless have a detrimental effect on the speed of the ship.

The vacuum system comprises every part under the influence of vacuum, and what is accepted as an air-tight system is one in which every joint, gland, valve, cock, or other connection is capable of resisting the admission of any air. This condition is arrived at in practice by a process of tuning up, which means exercising the greatest possible care in workmanship, going over all the joints and connections with paint or varnish and carefully examining every fitting, including even the cocks and union nipples of the vacuum gages. A difficult and tedious task, as Admiralty contractors know full well. If the air pump capacity of the ship is determined on the basis of ideal tightness, then unless such ideal tightness is achieved there can be no improvement except by driving the air pump in excess of the regulation limit, an expedient which is admittedly unsatisfactory. The all-important question is, will ideal air-tightness be maintained under the severe conditions of war, and if not maintained can the possible leakage at once be located and stopped? My reply, based on long experience with high vacuum plants of the highest class, would be in the negative, as I have found it futile to expect continued maintenance of ideal tightness. Insidious leakage always commences, and the invariable opinion of engineers in charge of high-vacuum plants is that air leakage is sooner or later in-

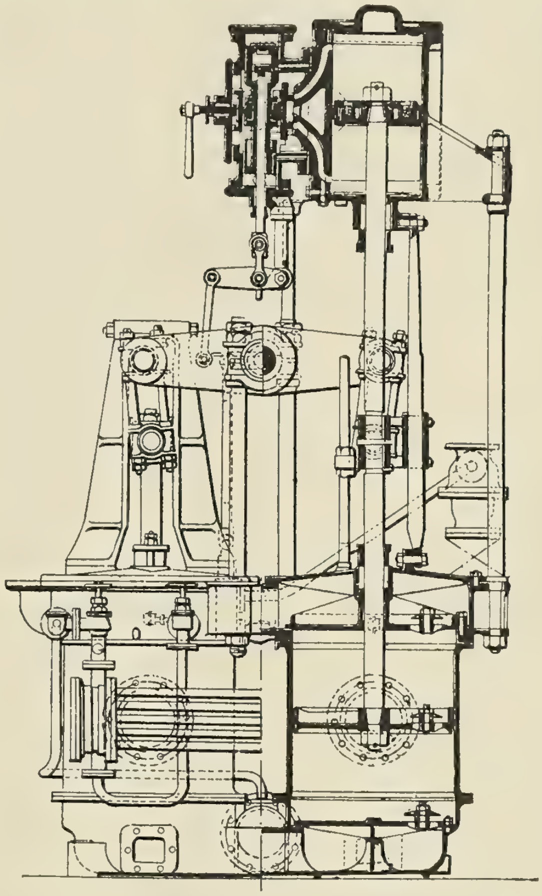


FIG. 3.—INDEPENDENT WET AND DRY AIR PUMPS

evitable and generally very difficult indeed to locate. If such is the position on land, what may be expected under the severity of the conditions of vibration, shock and stress certain to be associated with a naval action. Under peace conditions the position never becomes serious, as the standard of maintained excellence on a warship is extremely high, as is also the standard of the *personnel*. It is in war time that this question will become acute. The endurance of every man has its limit, and what the physical condition of the engineering *personnel*

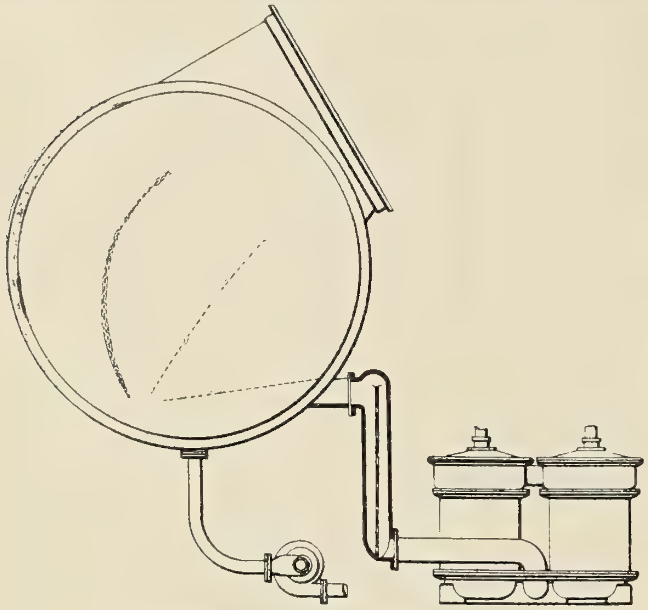


FIG. 4.—SEMI-ROTARY SYSTEM OF AIR PUMPS

after a few days of war in deadly earnest will be is a question in reply to which we all pray may be long deferred.

I would here refer those to whom my fears may appear exaggerated or groundless to Fig. 1. In the next naval war in which modern ships are engaged it will be reliability of performance which will tell. It is not enough that a ship *has traveled* at her designed speed; it is rather that such precautions are taken that she *will travel* at that speed when required, notwithstanding trifling departures from the normal.

Having set forth the essential contention of this paper, it will be useful to refer in a general way to types of air pumps which embody distinctive features, in order to ascertain to what extent an air margin can be provided consistently with the exacting requirements of the problem. The air pumps in the British navy are of the reciprocating type, although a rotary one, on the kinetic principle, was recently fitted on a torpedo boat. In 1908 the writer, in a paper on "The Influence of Air on Vacuum in Surface Condensers," dealt at length with the advantages obtainable by what is known as a "cooled dry air pump." In 1909 the Admiralty adopted the air pump shown in Fig. 2. It consists of twin wet and dry reciprocating pumps of the ordinary foot-and-bucket valve type, driven by one steam cylinder and levers in the ordinary way. The wet barrel withdraws the water and the so-called dry barrel the air, the feature of interest being that the air delivered by the dry barrel into its discharge chamber passes through a loaded valve into the wet barrel between the bucket and the delivery valves, and is discharged thence with the condensate in the ordinary manner. This valve is loaded to 4 pounds per square inch, and therefore the load on the bucket of the dry barrel is lessened, thus favorably influencing the power required. The air-withdrawing capacity of the dry barrel is practically unaffected by the reduction in discharge pressure, and in this system the pumps are not independent.

Fig. 3 represents another system of wet and dry reciprocating air pumps. The wet and dry barrels, the water-cooling arrangement, and, indeed, all details, are broadly similar in Figs. 2 and 3, except that in Fig. 3 the dry pump delivers direct to the atmosphere. The wet and dry barrels are, therefore, independent in every way, so that in the event of the breakdown or derangement of either pump, the other can withdraw both air and water from the condenser. The vapor withdrawn from the condenser with the air and discharged by the dry pump as water may be taken from the discharge chamber by a small plunger pump driven from the lever and delivered to the feed tank or elsewhere as desired.

In each of these systems (Figs. 2 and 3) the whole of the water is withdrawn from the condenser by the wet barrel, and as the amount at full power is considerable, and in a seaway erratic in supply, it follows that the speed at which the pumps can be driven with safety is governed by the water considerations of the wet pump. This is termed the Admiralty limit speed, and must not be exceeded on a warship full-power trial.

Fig. 4 shows a semi-rotary system whereby the water is withdrawn by a small rotary pump, working in combination with reciprocating pumps, thus rendering both barrels of the reciprocating pumps available for withdrawing air. When in harbor, or when cruising at low speeds, the rotary pump may be stopped and the water and air withdrawn on the wet and

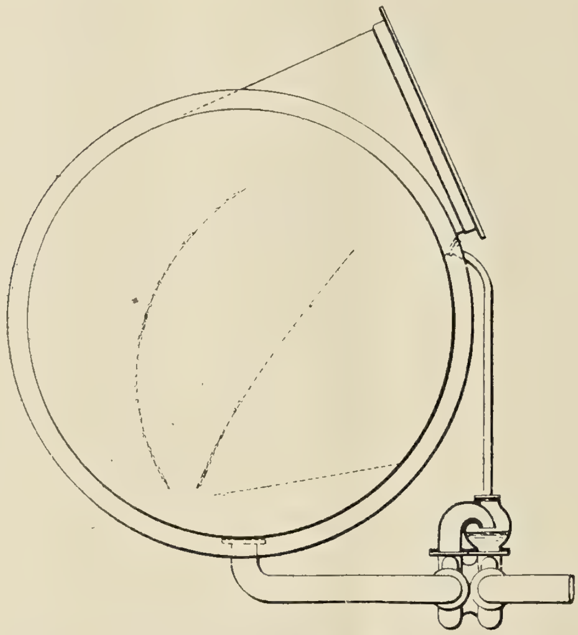


FIG. 5.—CONDENSATE PUMP, HEAD AND PRESSURE SYSTEM

dry system as in Fig. 3. Fig. 4 also shows a safety device placed between the rotary and reciprocating pumps, so that in the event of a sudden stoppage of the rotary pump the water would be automatically and gradually delivered to the reciprocating pump, thereby preventing shocks. This safety device is of value in combination with any reciprocating water-extracting pump, particularly in a heavy seaway, when sudden gluts of water are inevitable.

The semi-rotary system (Fig. 4) involves the use of a centrifugal water-extracting pump driven by either a small steam turbine or an electric motor. For a condenser dealing with steam from a 10,000-horsepower main turbine, the horsepower would, even with a considerable margin, not exceed 10. What are the advantages? For example, take the air-withdrawing capacity of a pair of wet and dry pumps (Fig. 2) at the regulation number of strokes per minute. The air-withdrawing capacity of a set of pumps on the semi-rotary system, with the same diameter and stroke, is increased by about 50 percent. Moreover, in the semi-rotary system, as both barrels draw air only, and each barrel is supplied with a constant and uniform quantity of sealing water per stroke, the regulation number of strokes per minute can be increased by at least 50 percent without affecting the margin of safety and durability. Therefore, by the addition of a small centrifugal pump, the ultimate air-withdrawing capacity is more than doubled. Another feature of advantage is that even under conditions of extreme severity—for instance, at full power in a heavy seaway—the factor of safety on the reciprocating air-pump mechanism is constant. There are neither shocks nor jars due to gluts of water in irregular supply, the working of the pumps is smooth and regular, and is totally unaffected by variable quantity of condensate. In harbor, or when it is not necessary to work the rotary pump, the operation of a change valve enables the reciprocating pumps to be converted from parallel working as dry air pumps into the wet and dry system, whereby the air-pump duty under light loads is maintained with a minimum consumption of steam.

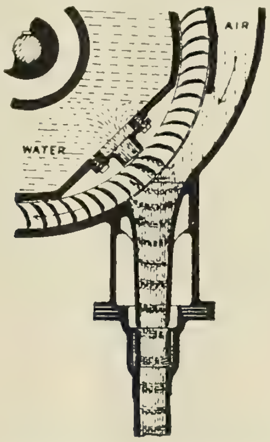


FIG. 6.—ROTARY AIR EXTRACTOR, WATER TURBINE SYSTEM

Fig. 5 shows a type of "head and pressure" condensate pump, which is very reliable in practice. There are two impellers—the first discharges into an air-separating chamber at or about the normally maintained suction level of the second pump. From this chamber extends a vertical standpipe, which is connected at the top to the condenser. No lodgement of air is possible in this pump. It will work under a suction head of as little as from 6 inches to 9 inches, and is designed to meet marine requirements.

The steam economy of such a small turbine as 10 brake-horsepower is low, so that an alternative drive for this pump would be by an enclosed waterproof electric motor, thereby favorably influencing the steam consumption. There can be no question as to the great increase in air capacity obtainable by this semi-rotary system, and notwithstanding all that Fig. 1 may mean to a warship, it might be legitimate to reduce the size of the reciprocating pumps by an amount which would compensate in part for the weight of the small centrifugals. That, however, is a question which must be left to the decision of naval experts.

Another feature of this semi-rotary system is that it can be fitted to existing ships with a minimum of disturbance and cost. Whenever the system is tried in this manner the advantages at full power, and especially in a seaway, will be found to be very considerable when compared with the pure reciprocating system, the inherent defect of which is the extremely low volumetric efficiency of the wet barrel as a withdrawer of both air and water.

The designer of warship machinery when considering any new development naturally hesitates before recommending a radical change, as there are so many requirements which have to be met, but the semi-rotary system of air pumps involves not so much a change as an addition, viz.: a very small motor-driven centrifugal added to known and existing air-withdrawing apparatus. By means of this small addition the available air capacity at the full speed of the ship is more than doubled; the factor of safety of the existing mechanism is considerably increased, and the admitted steam economy for harbor duty is retained. Moreover, the semi-rotary system is a step forward towards the realization of the complete rotary system, in that it enables experience to be gained on an essential part of the complete rotary system, viz.: the rotary water extractor.

Suppose, for instance, on a 30,000-horsepower cruiser there were four such centrifugals weighing collectively with pipes 4 tons; again, suppose a fall in vacuum by air of only 1 inch. Such a fall would involve an effective loss of about 20 tons of coal per 24 hours, or five times the weight of the apparatus.

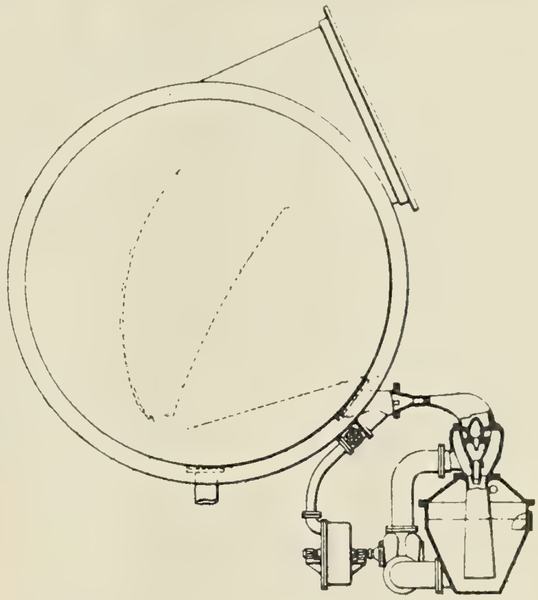


FIG. 7.—AIR WITHDRAWN BY COMBINED STEAM AND CONDENSATE JETS

In other words, the entire weight of the apparatus would be represented by the coal wasted in 24 hours by a fall of about one-quarter of an inch in vacuum, caused by insufficient air-pump capacity.

Sir Charles Parsons' well-known system of combining a steam jet air-withdrawing device with a reciprocating air pump, the steam from the jet being condensed in an intermediate surface condenser, has frequently been described in the *Transactions* of this institution, and is well known to be a highly efficient apparatus.

Fig. 6 shows in diagrammatic outline a rotary air pump which withdraws the air by water films discharged from a turbine wheel. If sea water is used for air-expelling purposes the water resulting from the condensation of the vapor necessarily withdrawn along with the air is lost. Another feature is that the theoretical limit of vacuum is not the barometric pressure but the vacuum corresponding to the temperature of the sea water used for air-expelling purposes.

Fig. 7 shows a complete rotary system whereby the air is withdrawn and discharged by means of the kinetic energy of combined steam and water jets. It is in extensive use on land, and has been sanctioned and is under construction for one of the light armored cruisers at present building. An outstanding feature of the apparatus is that the air-expelling medium is the condensate, so that the entire heat of the steam jet, together with the vapor withdrawn from the condenser, is absorbed and conserved. There is no loss of heat and no loss of water; in fact, neglecting radiation, the thermal efficiency of the system is unity, and, what is very important, the basis limit of rarefaction by the apparatus is the barometric pressure. The condensate is withdrawn by a centrifugal pump, and passes into a circulating receiver, from which it flows to the feed tank. The air is withdrawn from the condenser by a steam jet, and the aerated steam is discharged into a chamber in which condensate is sprayed by multiple jets, thereby presenting a large water surface by which the steam from the jet is condensed, and on which the air is, as it were, automatically deposited. The resultant highly aerated water is delivered to an annular water jet in the base of the chamber by which it is discharged. An ordinary centrifugal pump draws water from the circulating receiver and delivers it to the spraying jets and to the annular air-expelling jets. The

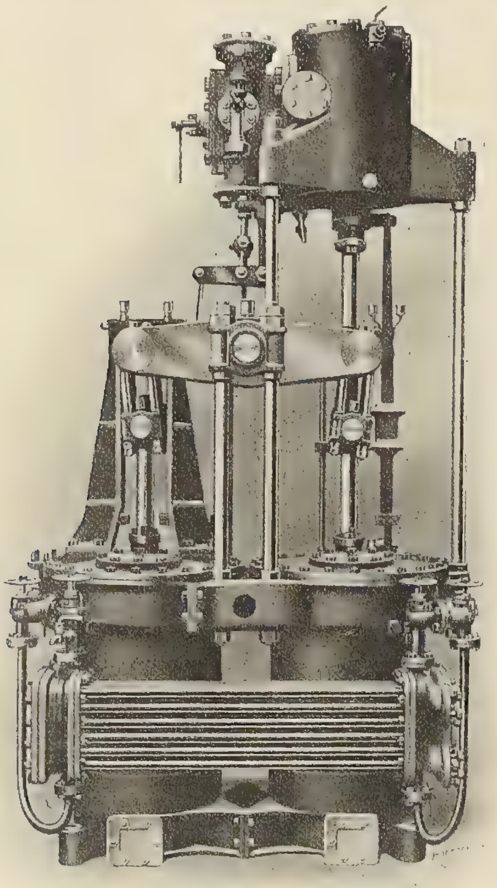


FIG. 8

steam jet is supplied from the closed exhaust system, therefore the apparatus becomes in effect an exhaust steam feed-water heater, but before heating the water the exhaust steam is usefully employed in withdrawing the air from the condenser. The centrifugal pump is driven by a small turbine, there being no other moving mechanism whatever. In a 30,000-horsepower cruiser there would be, say, four sets of apparatus, the water horsepower of each set being about 30.

It is well known that the steam consumption per horsepower of small steam turbines is high compared with that of a reciprocating engine, such as is used for driving the wet and dry reciprocating pumps, but when exhausting into the usual closed exhaust system about 70 percent of the work of which the steam as delivered to the small turbines was originally capable is still available for generating power on the low-pressure section of the main propelling turbine. In this connection it may be mentioned that the exhaust from this small turbine is dry, so is in an eminently suitable condition for admission to the main turbine, whereas the exhaust from the reciprocating engine is super-saturated. The apparatus is fascinating, because it is completely rotary, and, being so, it is uniform with the main turbines; it is also very simple. As a remover of highly rarefied air, such, for example, as is associated with 28½-inch vacuum, it is ideal. The air capacity of the four sets referred to is, at 28½-inch vacuum, more than double that of the ordinary installation of wet and dry reciprocating pumps usually fitted on a 30,000-horsepower cruiser. The system is essentially one for vacua over 26 inches, and the higher the vacuum the more strikingly efficient it is, provided in all cases the condenser is of suitable design.

In order to obtain reliable data, a very exhaustive series of tests has been made on the reciprocating air pumps shown in Fig. 8. The design meets Admiralty requirements, and is in accordance with recognized first-class practice. The method

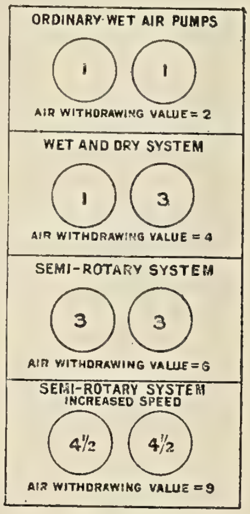


FIG. 9

of testing adopted was the usual one of withdrawing from a receiver into which air is admitted in known quantity, and through which water passes in known quantity and at known temperature. The results obtained from such tests are, of course, not identical in a quantitative sense with what might be expected from a condenser in actual operation; they, nevertheless, permit of exact comparisons being made.

The pumps were arranged to work on the following systems:

(*a*) Water withdrawn by wet barrel and air by dry barrel, both discharging to atmosphere.

(*b*) Water barrel discharging to atmosphere and air barrel against pressures below atmospheric.

(*c*) Both barrels withdrawing air in parallel as in semi-rotary system.

The temperature of the water passing through the wet barrel ranged from 70 to 120 degrees, and that passing through the dry barrel from 50 to 90 degrees, thereby covering all the conditions met with in practice.

Referring again to the basis example, viz., 28½ inches condenser vacuum with 55 degrees sea water, and assuming the condensate to be 80 degrees, the conclusions are as follows:

The air-withdrawing capacity of the dry barrel is about three times greater than the wet barrel.

There is no measurable difference in the quantity of air withdrawn by reducing the discharge pressure from atmospheric to, say, 4 pounds absolute.

If both barrels are worked dry in parallel, as in the semi-rotary system, the air capacity per minute is one-half greater than on the wet and dry system at the same number of strokes per minute.

With both barrels working in parallel as air barrels at a number of strokes per minute 50 percent greater than the regulation strokes permissible on the wet and dry system, the smoothness of working is at least equal to that obtained by the wet and dry system at the regulation strokes, and at this increased speed the air-withdrawing capacity is more than doubled. (See Fig. 9.)

Fig. 10 is a section of the apparatus on which experiments were made on air withdrawal by the kinetic energy of steam and water jets. The temperature of the condensate was again assumed to be 80 degrees, and 5 degrees were added for heating by the steam jet, so that the temperature of the water in the circulating tank was maintained throughout the tests at 85 degrees. The water-horsepower of the centrifugal pump supplying the jets was 33. With no air separately admitted, and with water at 85 degrees passing through the jets, a vacuum of 29.8 was maintained with barometer at 30 inches. A vacuum of 28½ inches was maintained under the above conditions with an air admission of 50 cubic feet per minute.

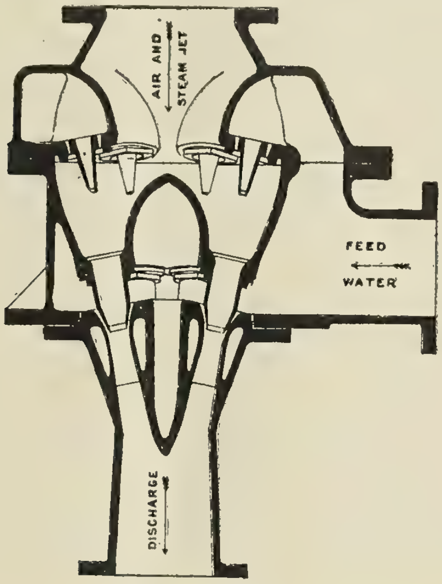


FIG. 10

A vacuum of 28 inches was maintained under the above conditions with an air admission of 65 cubic feet per minute. This result is beyond the requirements of ordinary practice, and was made to illustrate the possibilities of the system.

Having reviewed the broad question of air margin for air pumps the proposition I venture to submit for consideration is as follows:

There is an ascertainable and minimum quantity of air passing through a turbine system to the boiler as air in suspension and solution in the feed water, and from the boiler into the condenser as air in the steam, this quantity being based on the assumption that the joints, etc., in the vacuum system are absolutely air-tight.

If at full power the capacity of the air pumps at the specified vacuum is based on this quantity of air, the pumps may be said to have no air margin. In view of the influence of vacuum on power and of the influence of microscopic air leakages on vacuum, is it or is it not desirable to provide warship air pumps with an air margin at full power, and, if so, what should the air margin be relatively to the normal quantity of air passing through an air-tight system per unit weight of feed water?

In conclusion, I may say that my endeavor has been to set forth within the limits of a paper the influence of an air pump on the military efficiency of a turbine-driven warship. It is a subject which should appeal alike to the naval constructor, the naval engineer, and the commanding officer. Its consideration brings into prominence the far-sighted policy of the new scheme of naval training whereby all the officers in His Majesty's navy will have passed through an engineering course and be able in the future to review professionally the many subtle problems involved in that wonderful aggregation of mechanism—a modern warship.

Ocean-Going Twin Screw Salvage Tug for the Brazilian Government

The twin screw tug *Carioca* is an ocean-going vessel built by Messrs. Napier & Miller, Ltd., Old Kilmarnock, near Glasgow, for the Federal Government of Brazil under the inspection of the Brazilian Naval Commission.

The principal dimensions are: Length between perpendiculars, 120 feet; beam, molded, 20 feet; depth, molded, 9 feet 6 inches. The propelling machinery, supplied by Messrs. Miller & Macfie, Ltd., of Kinning Park, Glasgow, consists of two sets of three-crank triple expansion engines with cylinders 8 inches, 12 inches and 18 inches diameter, and 12-inch stroke, with one large boiler designed to give a speed of 10½ knots.


FIG. 1.—TUG CARIOCA LEAVING THE CLYDE

The cylinders are all cast separate, the high-pressure cylinders being provided with liners of good wearing cast iron.

The bed plate is of cast iron of "H" section throughout, a design which for small engines gives a combination of strength and lightness as well as simplicity. The cylinders on each engine are supported by six cast iron columns, also of "H" section, the front columns carrying both the ahead and the astern guides, in which case the propellers rotate outwards. The shafting is of mild steel throughout, the crankshaft being of the built-up type in one piece and having all dimensions in excess of Lloyd's requirements.

The tail shafts are so designed that they can be drawn outwards, and are lined with gun metal and suitably supported outboard by means of "A" brackets.

The propellers are three bladed and of solid cast iron. Both engines exhaust into one condenser. The condensing plant is of Messrs. Miller & Macfie's special design. The air, circulating and bilge pumps are worked by an independent reciprocating engine, and are situated at the forward end of the engine room, the piping to the condenser being led underneath the engine room floors. This arrangement of condensing plant has proved to be not only highly satisfactory, but also very convenient, as the exhaust of all the engine room and deck auxiliaries is led into the condenser. Provision is also made for the auxiliaries to exhaust into the atmosphere.

The air pump is of Edwards type, being 9½ inches in diameter by 6 inches stroke, and the circulating pump is of the centrifugal type, having a 4-inch discharge and an 18-inch impeller.

The engine has a 6-inch diameter cylinder by 6-inch stroke, and takes steam direct from the boiler. A Pickering type of governor is fitted to the pumping engine stop valve, and is driven off the end of the crank shaft by means of a belt.

There is a feed pump on both port and starboard engines, worked by levers off the crossheads of the high-pressure engines. Both pumps draw from hot well on the pumping engine, and they are so arranged that either or both pumps can be shut off, in which case the donkey pump, which is also connected to the hot well, can be used for feeding the boiler.

The engine room auxiliaries consist of the pumping engine

There are five watertight bulkheads, two of these forming fresh water tanks, and coal is carried in the cross bunker forward of the boiler room. All the decks are of teak, and the vessel has been classed at Lloyd's under special survey for Brazilian coastal service, and, in view of the fact that the *Carioca* will be regularly engaged in tropical waters, special attention has been paid to the ventilation of the accommodation.

The *Carioca* left the Clyde on June 4 for Rio.

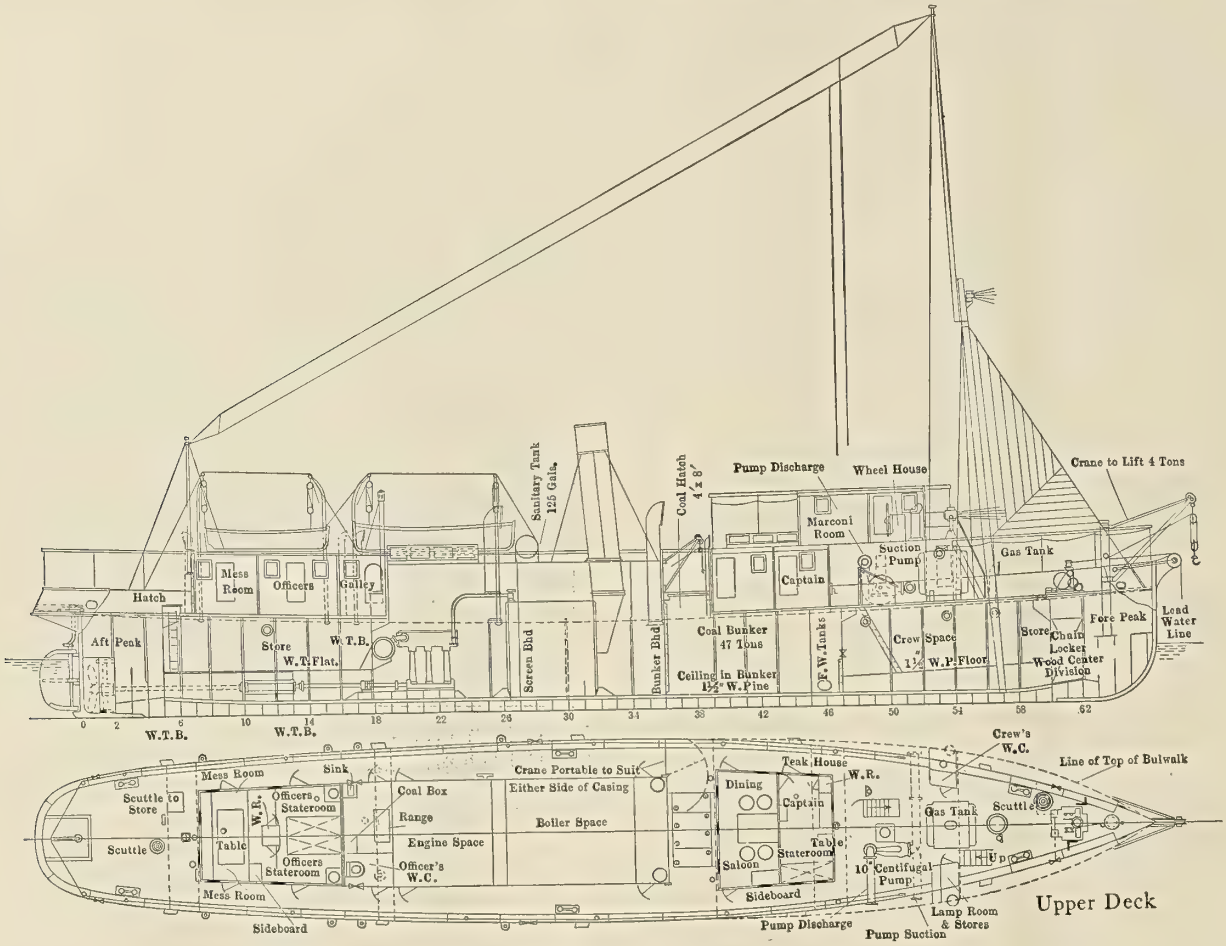


FIG. 2.—GENERAL ARRANGEMENT OF THE TWIN SCREW SALVAGE TUG CARIOCA

and a donkey pump, as already mentioned, and also a dynamo. The donkey pump can be used for circulating the condenser, and for various other purposes. The dynamo generates power for lighting the entire ship, as well as for a powerful searchlight situated on the navigating bridge, and for the Marconi wireless telegraphy apparatus. Situated on the main deck underneath the navigating bridge is a powerful centrifugal type salvage pump having a 10-inch diameter suction, driven direct by means of a reciprocating engine. It gets steam direct from the boiler and exhausts to condenser or atmosphere.

The suction and discharge pipes are so arranged that the pump can suck from or discharge to either side of the ship. A steam-driven windlass is fitted on the main deck forward for operating the anchors, as well as for salvage purposes, also a powerful fire pump, a complete diver's outfit, a rocket apparatus and a Pintsch gas pressure tank for charging lighted buoys. Accommodation for the crew is below the upper deck forward, while the officers and engineers are berthed in a large teak house abaft the engine casing, and the captain's quarters and the saloon are in the teak house forward. The Marconi operator's room (with silent chamber) is on the bridge.

Monthly Shipbuilding Returns.—The Bureau of Navigation reports 143 sailing, steam and unrigged vessels of 21,151 gross tons built in the United States and officially numbered during the month of August. On the Atlantic coast nine steel steamships, aggregating 6,447 gross tons, were built, while on the Great Lakes two steel steamships, aggregating 2,753 gross tons, were built. The largest steamship reported for the month was the *Narragansett*, of 3,538 gross tons, built by the Harlan & Hollingsworth Corporation, Wilmington, Del.

Contracts for New Destroyers.—Contracts for the construction of six torpedo boat destroyers for the United States navy were awarded conditionally September 16 by the Secretary of the Navy Department. The destroyers are to be 310 feet long, 29 feet 10 inches beam, 9 feet 3 inches draft, 1,090 tons displacement and 29½ knots speed. All of the destroyers will use oil fuel and will be equipped with turbine machinery. The contracts were awarded as follows. Two vessels to the New York Shipbuilding Company, Camden, N. J., at $825,000 (£169,000) each; two to William Cramp & Sons Ship & Engine Building Company, Philadelphia, at $881,000 (£180,000) each; one to Fore River Shipbuilding Corporation, Quincy, Mass., at $861,000 (£176,500), and one to the Bath Iron Works, Bath, Me., at $884,000 (£181,300).

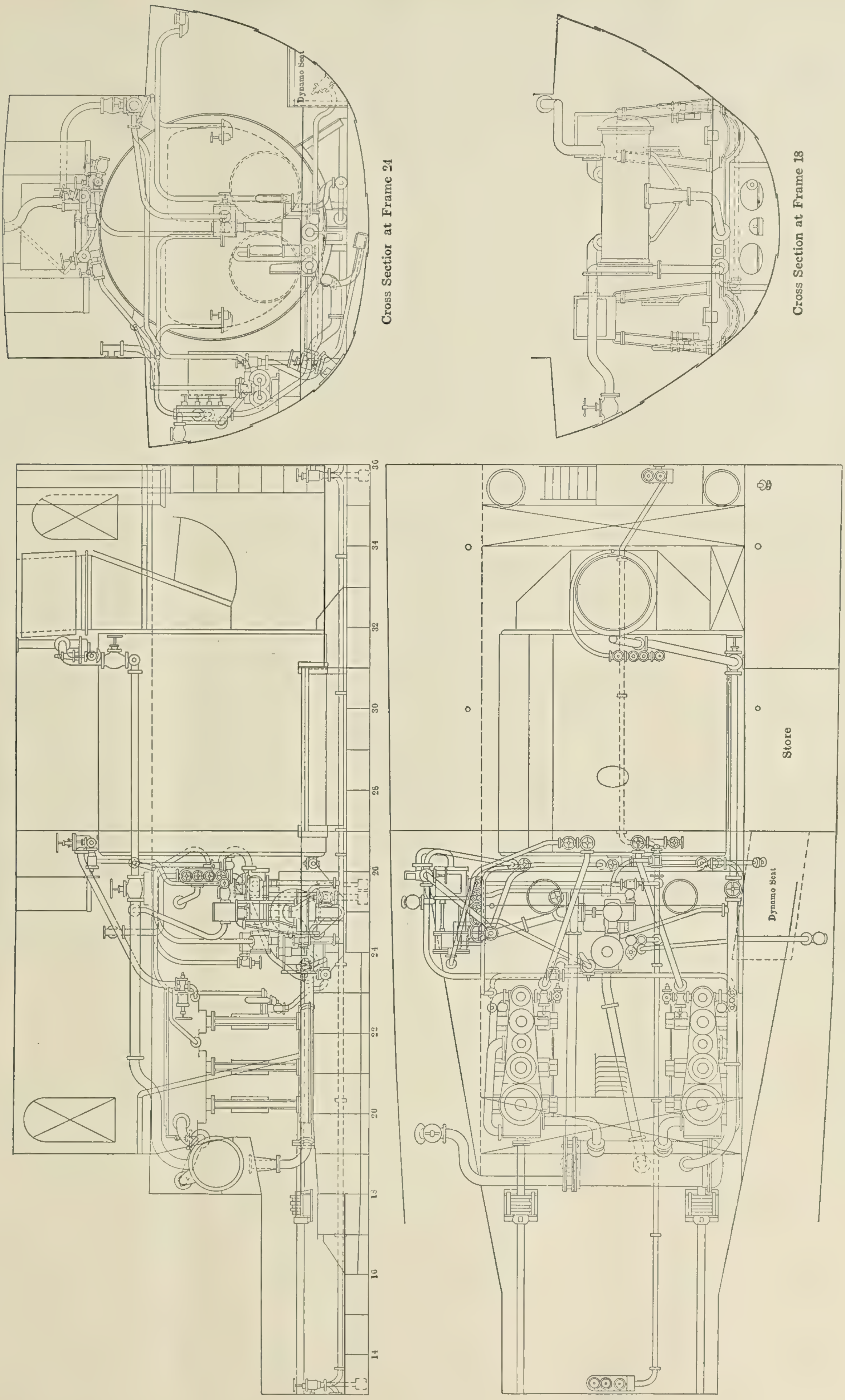


FIG. 3.—MACHINERY ARRANGEMENT OF THE TWIN SCREW OCEAN-GOING SALVAGE TUG CARIOCA, BUILT ON THE CLYDE FOR THE BRAZILIAN GOVERNMENT

Steel Screw Ferry-Boat Edward T. Jeffery

BY J. B. SHIPLEY

The new steel double-ended screw ferry-boat *Edward T. Jeffery,* built for the Western Pacific Railroad Company at the Oakland yards of the Moore & Scott Engineering & Shipbuilding Works, was launched July 19, and went into commission about Aug. 15, taking the place of the stern-wheel steamer *Telephone,* which formerly connected the Western Pacific Railroad system at its terminal pier in Oakland and the ferry depot at the foot of Market street, San Francisco, Cal. The new ferry-boat is equipped for the conveyance of passengers, express, baggage and mail, and will later take care of the suburban traffic over this line. The general dimensions of the vessel are:

Length, over all	230 feet
Length, center to center of rudder posts	218 feet
Beam, over guards	62 feet 6 inches
Beam, molded	42 feet
Depth to main deck	19 feet 6 inches
Displacement	1,150 tons
Total seating capacity	1,400 persons
Draft	11 feet 6 inches

The hull is of steel, the heaviest plates being 22½ pounds and the lightest 15 pounds. The stern frames at the ends are of cast steel of the form shown on the inboard profile, Fig. 2, and are made in two pieces fitted together with a scarph.

The rudders are of the balanced double-plate type, the frames being steel forgings in one piece with 15-pound side plates. The interior of the rudder is filled solid with wood and resin. A steel collar, formed upon the upper end of the rudder, bearing upon a babbitted surface formed around the pintle in the upper part of the stern post, will carry the weight of rudder.

The keel plate, of trough section, is 24 inches wide of 29½ pounds. A floor stringer 12 inches wide and of 15-pound plate is fitted to the top of the keelson. The frames are of angle section, 8½ pounds, spaced 24-inch centers amidship and 21-inch centers at the ends of the ship. Web frames are fitted in the machinery space. The bulkheads, belt frames and the keelson are fitted for stiffening the structure, while the frames merely stiffen the shell.

FIG. 1.—LAUNCH OF THE FERRY-BOAT EDWARD T. JEFFERY AT THE MOORE & SCOTT IRON WORKS, OAKLAND, CAL.

The deck beams are 11.6-pound Z-bars, fitted to every frame and supported by channel stringers and stanchions. The greater part of the main deck is covered with steel plating and wood-laid, as is the case over the overhanging beams supporting the guards. The guard braces are 10-pound angles, fitted to alternate beams, palmed at the lower end where riveted to the shell.

Special attention has been given to the subdivision of the hull, there being ten complete watertight compartments, formed by transverse and longitudinal bulkheads, with a watertight door between the engine and boiler rooms. The engine seating is strongly constructed of exceptional length, and is worked into the structure of the vessel. The superstructure is of wood throughout, and fitted with skeleton steel bulkheads, two on either side of vessel, extending from the main deck to the saloon deck. The builders hope to eliminate the vibration felt in the older vessels now plying San Francisco Bay in this more rigidly-constructed vessel, where every part is contributing to the general strength of the structure.

The enclosures around the engine room galley and restaurant up to the saloon deck and the engine-room skylight and boiler enclosure up to the upper deck are of 7½-pound plating. Steel doors are fitted to give access to the engine and boiler rooms and the restaurant off the main deck. There is a restaurant for ladies on the saloon deck and a grill on the lower deck for men.

On the main deck the interior is neatly and plainly finished in mahogany throughout, with T. & G. flooring covered with "Battleship Linoleum." The seats on the saloon deck are of mahogany with veneer backs, perforated. The crew's quarters are below the main deck aft of the engine room, and are light and roomy.

There is a combined steam and hand-steering gear. The steam gear has a hand wheel and control stand in each pilot house, with a 7-inch by 7-inch diameter by 6-inch stroke engine of the floating lever type placed in the hold below the pilot house, as shown on the inboard profile, Fig. 2. The hand gear consists of a drum in each pilot, operated by a 6-foot hand wheel, and has wire rope running below to a crosshead, to which the tiller chain is attached. This arrangement can be thrown out of gear when the steam gear is in action.

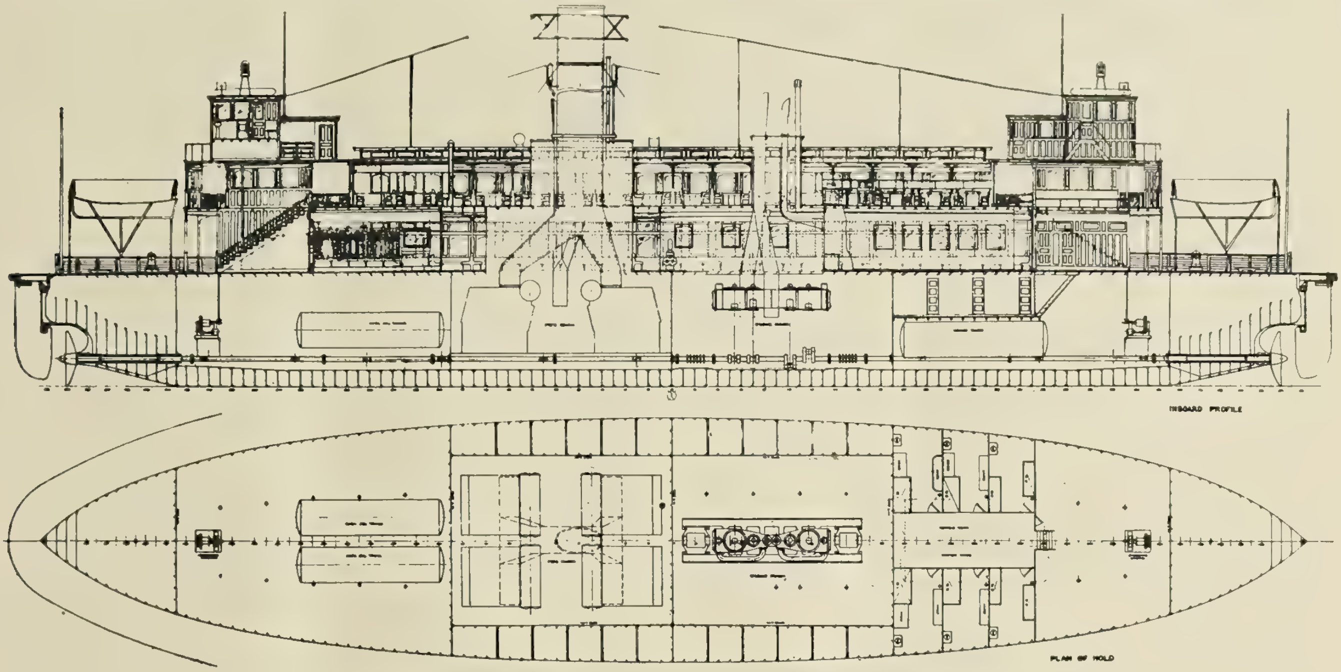


FIG. 2.—INBOARD PROFILE AND HOLD PLAN OF THE EDWARD T. JEFFERY

The propelling machinery consists of two sets of inverted, direct-acting compound surface condensing engines, with cylinders 20 inches and 42 inches in diameter by 28 inches stroke. The engines actuate a shaft carrying a propeller at each end of the ship, at a working steam pressure of 160 pounds per square inch at the throttle; the engines turn up about 150 revolutions per minute, equaling a piston speed of 700 feet per minute. At this speed the indicated horsepower is about 2,600.

The two sets of engines are coupled together, with the high-

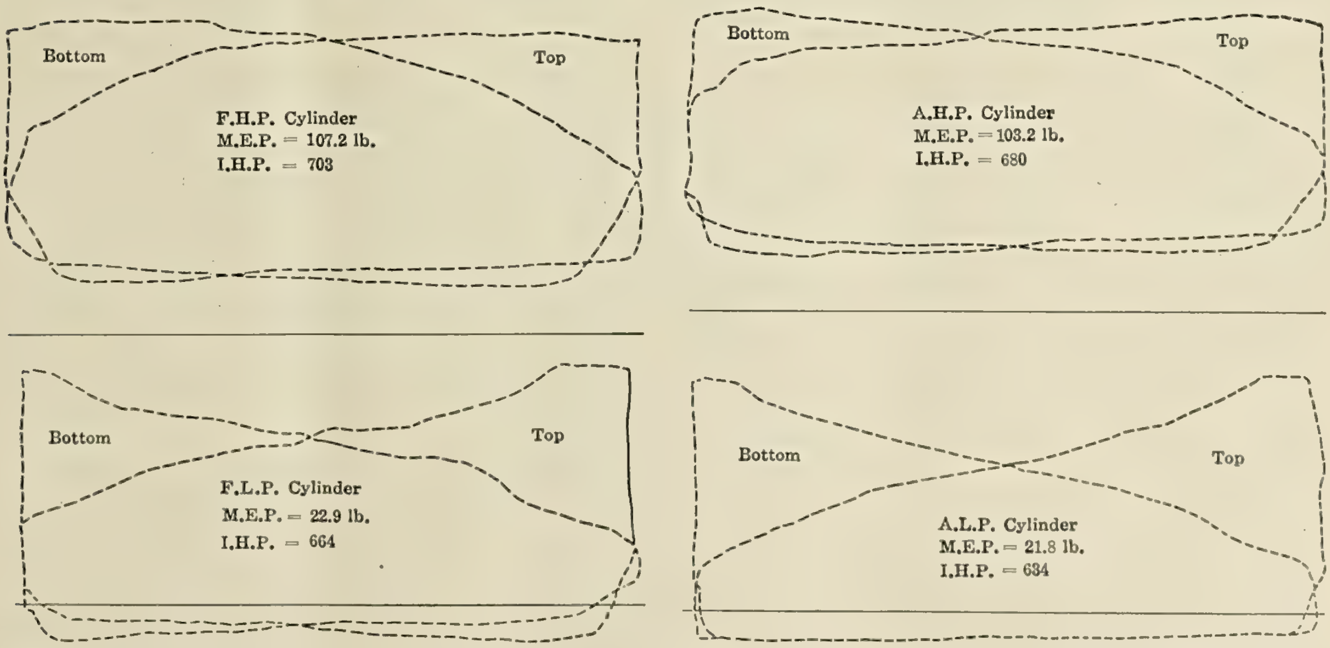


FIG. 3.—INDICATION CARDS (NOT SHOWN FULL SIZE) TAKEN FROM THE ENGINES OF THE FERRY-BOAT EDWARD T. JEFFERY ON HER OFFICIAL TRIALS IN SAN FRANCISCO BAY, AUGUST 11

pressure cylinders in the middle with cranks at an angle of 90 degrees. The low-pressure cylinders are at either end with cranks opposite their respective high-pressure cranks. Each cylinder is cast with its steam chest, and the cylinders of each engine are firmly bolted together. Furthermore, the two high-pressure cylinders are bolted together at the center. The high-pressure cylinders are fitted with liners and 10-inch diameter piston valves. The low-pressure cylinders are fitted with double-ported slide valves having the American balance. They are also provided with 8-inch diameter assistant cylinders.

Cast iron box section columns of the inverted "Y" pattern support the cylinders at the back, while at the front there are turned columns of machinery steel 4½ inches in diameter. The bedplate is of box section, cast iron, in two pieces, bolted together at the center; and into each section are formed the three main journal boxes. Extensions at each end of the bedplate take the thrust bearings.

The high-pressure pistons are of cast steel, conical dished shape and fitted with improved design clamp packing ring. The piston rods are of machinery steel, 4½ inches diameter. The connecting rods, which are 70 inches long between centers and forked at the upper ends to take the crosshead brasses, are 4 inches diameter at the upper end and 4¾ inches diameter at the lower ends. The crankpin brasses are of cast steel lined with white metal. The double forged steel crosshead pins are 5 inches diameter by 5¾ inches long. The crosshead guide, which is of cast iron 10 inches wide by 5¾ inches deep, is cored out for water circulation. All stuffing boxes are fitted with Tucker's metallic packing, and a complete water service and oil lubrication system is provided.

The valve gear is of the Stephenson type, with double bar links 1⅜ inches thick by 3½ inches deep. The link blocks are of composition, with pins 3¾ inches diameter by 2¾ inches long with gibs of composition 8½ inches long. The eccentric rods are of forged machinery steel forked at top ends and fitted with adjustable brasses. The eccentric sheaves are of cast iron, 20 inches in diameter by 3¾ inches face, and the eccentric straps are lined with white metal. Reversing is accomplished by a steam gear of the floating lever type, with a steam cylinder 12 inches diameter and water cylinder 5 inches diameter by 14¾ inches stroke.

The crankshaft is in two pieces, of forged machinery steel 9 inches diameter, and of the built-up type. The crankpins are 9 inches diameter by 11 inches long, with webs 6½ inches thick. The pins are shrunk into the webs and keyed. There is one length of thrust shaft 9 inches diameter at both ends of crankshaft. On each thrust shaft six collars are turned out of the solid, 17 inches diameter by 2 inches thick, with a 4½-inch space between the collars. Thrust collars of usual horseshoe type, faced with white metal and cored out for water circulation, are provided. The line shaft is 9 inches diameter, rough turned, except at spring bearings, where it is finished. The propeller shaft, 9 inches diameter, is of forged steel with composition liners. Between the liners the shaft is painted and covered with canvas and wrapped with marlin laid in pitch. Cast iron stern tubes are placed at each end of vessel and lined with lignum vitæ staves.

The engine jacking gear consists of a cast steel worm wheel keyed to the crankshaft and operated by a bronze worm fitted in a bracket on the bedplate.

Both the bow and stern propellers are right-hand screws of solid cast iron, four-bladed. They are 9 feet 9 inches diameter by 12 feet pitch, with a pitch ratio of 1.19 to 1. The helicoidal area of the four blades is 40 square feet, and the blades are of pear shape thrown back 12 inches at the tip, which is abnormal, but which has been found to give better efficiency for the bow propeller, which is backing when the ship is going ahead.

Steam is supplied by four boilers of the Babcock & Wilcox watertube type, designed for a working pressure of 200 pounds per square inch. The boilers are 13 feet 9 inches long, 11 feet 7 inches wide and 11 feet 3 inches in height, with 42-inch steam drum by 12 feet long, made of ½-inch plate. The tubes are 2 inches and 4 inches in diameter, of No. 10 and No. 6 B. W. G. thickness, respectively. The total heating surface of the four boilers is 10,000 square feet, and the total grate surface is 234 square feet. The waste gases from the four boilers pass into one stack of an elliptical section, with inside dimensions 4 feet 6 inches by 8 feet, which extends 57 feet above the top of breeching and is double throughout.

The exhaust from the low-pressure cylinder of each engine is led to one main condenser with 52 inches inside diameter, containing 2,708 square feet of cooling surface, provided by 1,825 ⅝-inch tubes 9 feet long between the tube sheets. There is a feed-water heater with 200 square feet of heating surface, into which the exhaust from all the auxiliaries is led. The pressure in the heater is regulated by a back pressure valve fitted on top of the condenser.

The two main boiler feed pumps are of the Blake vertical simplex type, having steam cylinders 12 inches diameter, water cylinders 7 inches diameter with a common stroke of 12 inches, controlled by a float in the feed and filter tank. The air pump is a Blake single-acting twin beam pump, with two steam cylinders 9 inches diameter and a common stroke of 12 inches. Attached to the beam of the air pump is a plunger pump 1¼ inches diameter by 12 inches stroke, provided with a ½-inch suction to main engine crank pits to discharge the waste lubricants into the stern tubes at each end of the vessel. There is a centrifugal circulating pump with 12-inch suction connected to the sea or bilge, which circulates water through the condenser and overboard. The pump runner is of composition, 32 inches diameter, with a 2½-inch mouth. The driving engine has cylinders 6 inches and 12 inches diameter by 8 inches stroke, and operates at 300 revolutions per minute. The bilge pump, which is a Blake horizontal duplex, with cylinders 6½ inches, 4 inches by 6 inches, is located in the engine room, and connected to the bilge suction manifold box for pumping out all holds, peak tanks, engine and fire-room bilges. This pump is also connected to the sea and can pump into the fire main. It is also fitted to circulate water through the condenser. There is a horizontal Blake duplex fire pump with cylinders 10 inches, 7 inches by 12 inches, located in the engine hatch off the main deck, which pumps into the fire line and supplies water to eight 50-foot hose reels, so distributed as to reach all parts of the vessel. The fire pump is also fitted to pump from the bilges and to circulate water through the condenser. There are also two hand deck pumps, 4 inches diameter by 5 inches stroke, and connected to the sea and to hose reels, one at either end of the house on the main deck. The fresh-water pump is a Blake horizontal duplex, with cylinders 5¼ inches, 4¾ inches by 5 inches stroke, connected to fresh-water tanks in the hold aft of the engine room and discharge into a tank on the hurricane deck provided for drinking faucets and galley use.

The boilers are fitted for burning fuel oil, the "Owens" steam burner being used. Fuel oil is carried in two tanks, 6 feet diameter by 26 feet long, in the hold forward of the boiler room. Two oil pumps, horizontal duplex, with cylinders 5¼ inches, 4¾ inches by 5 inches, provided with suction and discharge strainers, discharge through a cast iron heater fitted with a steam coil of 15 square feet heating surface. The oil pumps are controlled by a regular pump governor.

The electric generating set consists of two 20-kilowatt General Electric Company marine type sets, driven by reciprocating engines.

On the official trial trip, which was run Aug. 11, the engines and boilers showed up to the best advantage. The maximum indicated horsepower, as may be seen by the cards accompanying (these cards show the average indicated horsepower) this article, was 3,100 at a speed of 165 revolutions per minute of the main engines. The average of six trials over the measured course on San Francisco Bay was 14.97 knots, or 17 miles per hour.

The plans of the hull and the specifications were drawn up by Mr. J. H. Hopps, of San Francisco, consulting engineer for the Western Pacific Railroad Company.

The New Liverpool Dock

BY TH. OSBORNE

The continually increasing American traffic has necessitated the construction of an enormous additional dock at Liverpool, which has just been declared open with befitting ceremony by the King.

To a casual observer, a dock is almost too simple and obvious a structure to seem requiring any very great experience and study, but more detailed consideration must show quite the reverse is the case, more especially of very large modern docks, which, in addition to providing safe quayage for vessels, must be equipped with machinery and structures thoroughly designed to accomplish the loading, discharging and dispatch of cargo and passengers with safety and due economy of time and money; moreover, the repair of ships must also be facilitated. Beyond all these considerations there is the basic scheme of the docks as a unified system and as part of the commercial facilities of the great port and the country as a whole. The position and design of each dock and of all its equipments must fit in harmoniously with this basic scheme.

The great new dock, named the Gladstone Dock, has been essentially planned to be a graving dock for the repair and overhauling of those vast vessels which are now provided for the transatlantic traffic, and for the still larger ones, which many predict will be constructed before this dock will have been in existence for many years. When it is not engaged for this purpose it will be available as an ordinary wet dock for loading and discharging cargo and stores. The largest ocean liners at Liverpool are not generally taken into the docks to discharge their passengers, who generally leave via the great Prince's floating landing stage. The new dock, while therefore of suitable length, is intentionally narrow in comparison with the larger of the wet docks, as it is only intended to hold one vessel at a time, whereas a wet dock would have width for ships at each side wall in addition to passageway along the center.

The new dock is 1050 feet long inside the sliding caisson, or gate, and there is an entrance 120 feet wide. The width of the dock itself is 141 feet in the lower part, spreading out to 155 feet 6 inches wide at the water level. The walls are vertical, and the increased higher width is obtained by their being stepped in two places, so as to provide dock facilities. The depth over the entrance sill is no less than 46 feet at high water of the ordinary spring tides. This dock was originally designed to provide for vessels of the type of the Cunard liner *Aquitania* and others expected to follow; it is therefore desirable to recall the fact that this vessel is 902 feet in length over all, with a width of 97 feet. Her loaded draft is 34 feet, but this might be increased should the vessel at any time be damaged. Moreover, the general policy of naval architects is tending to designing vessels of even greater draft, whenever the harbors intended to receive them can be improved sufficiently to provide the necessary depth of water.

In accordance with its dual character, although the new dock is essentially intended to be a graving dock, it has been provided along one side with a one-story transit shed for cargo and stores. It is, moreover, a portion of a more comprehensive scheme designed to include two large branch docks, respectively 1,300 and 1,325 feet long and 400 feet wide, intended to be placed in the space south of the present dock and the Hornby dock, which up to now has been the most northerly of the great range of Liverpool docks. It is intended that these two branch docks will open into a Gladstone half-tide dock with two lock entrances pointing up river, and they will also be connected with the Hornby and other docks. When this great dock system will have been completed, the longest quay will provide facilities for a ship no less than 1,500 feet in length without interfering with maneuvering in the half-tide dock.

Still further north along the shore, the Liverpool Dock Board possesses an extensive area of land available for future dock development, so that the increase of the great port in the estuary of the Mersey is amply provided generations ahead.

It is doubtful whether any other European harbor can compare with that of Liverpool, now that the bar has, at enormous cost, been dredged; the docks are virtually non-tidal, and by far the larger number, which are constructed in groups, have been provided with tidal or half-tidal basins. A tidal basin is practically a sheltered collecting basin for shipping, as vessels are able to enter and leave the dock with greater safety than when they enter directly from the flowing tidal water. It is important to note that tidal basins are particularly advantageous where there may be several ships wishing to enter or leave about the same time. In several instances, the tidal basins may have gates at both ends, so as to convert them into huge locks, but in most they are completely tidal. A half-tidal basin, of which there are several, is always provided with tide gates, which are usually open for, say, two hours, more or less, before high water until some little time after full tide. In the projected Gladstone half-tide basin the river entrances will be large, full-sized locks, so that the fluctuation in level of the basin will not be very great.

European ports vary; some of them are not subject to high tides, and in such cases the docks may be perpetually open to tide water, provided, of course, that the docks are efficiently protected from rough weather. A breakwater is the ordinary protection. A typical instance is the docks at Marseilles, fronting the Mediterranean, also Milwaukee, Toronto and other ports on the Great North American Lakes. The open dock is very generally found along the Northern American coasts, where the great ports frequently have sheltered harbors, combined with very slight tidal fluctuations. New York, Philadelphia and Boston may be mentioned as interesting examples, the docks being formed for the major portion by a series of jetties, often of timber, projecting into the rivers. This system of harbor construction has the advantage of not involving any exceptionally large outlay of capital, but it is most suitable for a wide estuary, for unless the river is a very wide one it restricts the channel very seriously, and in that event the docks require to have a greater or less portion of their length excavated out of the shore.

Along the west coast of Europe, including Great Britain, open docks are not possible, but Southampton is a noteworthy exception. On the other hand, a very large outlay is necessary to provide each individual dock with its own gates and locks. Properly engineered docks are now practically invariably arranged in a group branching from an extensive basin, with ample space for the movement of vessels, this in turn communicating by means of locks and gates with tide water. This system, it will be noted, has points of resemblance with the sheltered open docks of Marseilles, the main difference being that the passageways through the breakwater at Marseilles do not require gates or locks.

Assuming that there is an ample depth of water, then, obviously the simplest and most economical construction is the shore quay or wharf, generally seen along the banks of rivers and lakes, but they are only applicable for a limited traffic, sheltered water and reasonably small tidal fluctuations of level. The system yields a minimum of accommodation for a given frontage, but it has advantages where ships have to leave at all times, and frequently also where the tidal conditions would make this almost impossible with ordinary docks.

Both systems can be seen side by side at Liverpool, where there is an obvious want for a riverside quay, in addition to the docks, for passenger steamers, more especially the ferry-boats and steamers crossing to Ireland or traversing the Irish Sea in various directions to Scotch and English ports. It is scarcely necessary to describe here how cleverly this requirement has been met, in spite of the great tidal fluctuations, ranging up to 31 feet by the widely-known Prince's floating landing stage, which is connected by means of hinged roadways with the shore.

In Great Britain the construction is generally of a very substantial and permanent character, with the minimum of timber and other semi-perishable materials. This applies to both graving docks and wet docks. Not very long ago prominent engineers somewhat severely criticised British dock construction. It was suggested that it was too substantial, and by its very permanency retarded development in ship construction, so far as related to their length. It must be admitted that this criticism is not without some justification, but in the case of a growing port it should be remembered that as the ships increase in size, so too, usually, does the trade of the port, and in any event, therefore, new docks have from time to time to be constructed, each providing for the requirements of the day. The natural consequence is that the more recent docks are planned to accommodate the largest vessels, while all the remainder can be comfortably accommodated in the older docks. Thus, comparatively few of the Liverpool docks have become useless because of the growth of shipping, although some have been modified or removed to provide space for shore improvements. Even graving docks seldom cease to be abundantly serviceable after the largest ships have become too large to enter them.

After increased dimensions, probably the most striking development in dock equipment during the last decade or so has been in the more ample provision of mechanical handling appliances, both on the quays and in the transit sheds themselves. The old hand cranes have long since disappeared, and have been replaced by steam, electric or hydraulic cranes, hoists and capstans, and even to endless traveling bands for handling baggage, grain, coal, ore and other bulk cargoes. Excepting American ports, Liverpool is probably the best equipped and most up-to-date port of the world.

New Pacific Liner Built at Newport News

The *Matsonia*, a steel single-screw steamship, to be completed in October by the Newport News Shipbuilding & Dry Dock Company, of Newport News, Va., is the latest addition to the Matson Navigation Company's fleet, and is intended to maintain a regular service between San Francisco and Honolulu, Hawaii.

She will be equipped for carrying a large amount of cargo, and also is provided with modern and up-to-date quarters for the accommodation of 246 first class passengers and 78 steerage passengers, as well as a crew of 121 officers and men.

The ship has been constructed in full accordance with Lloyd's Register of Shipping, Class +100-A1. The leading particulars of the vessel are:

Length, over all....................	500 feet
Length between perpendiculars.....	484 feet
Breadth, molded	58 feet
Depth, molded to shelter deck......	44 feet 9 inches
Sea speed, loaded to 24-foot draft...	16 knots
Displacement at 24-foot draft......	13,500 tons

The machinery is located aft, as on the other vessels of this line. The cargo will be carried forward of the machinery space below the upper deck and in the portion of the upper 'tween decks forward of the dining saloon. Provision is made for carrying a large supply of fuel oil, the lower part of the forward hold being arranged for fuel oil storage, as well as the double bottoms, which are made deeper than usual, and the forepeak. Amidships, in the hold, is a tank for carrying over 200,000 gallons of molasses, with pumping plant adjacent. This tank is also arranged for carrying fuel oil on emergency. A large space on the lower 'tween decks is fitted up for carrying refrigerated cargo, and the upper 'tween deck forward is arranged especially for the carriage of bananas. The total space available for cargo is about 450,000 cubic feet, exclusive of the molasses tank.

The upper deck amidships, as well as two tiers of houses above the shelter deck, are devoted to the accommodation of passengers. The deck officers' quarters and pilot house are located in a teak house above the passenger quarters. On the shelter deck aft are located the purser's office and Marconi rooms. The seamen's quarters are located in the forecastle, while aft on the upper and shelter decks are located quarters for the engineers, stewards' department, etc. On the shelter deck is provided a social hall forward, with deck houses aft, containing staterooms opening onto a wide and spacious promenade extending the entire length of the vessel. Below on the upper deck and well forward is the dining saloon; aft of which are first class staterooms, toilets, pantry, galley, and farther aft are spaces for steerage passengers. On the bridge deck, forward, is the smoking-room, and aft of this are located additional staterooms, wherever possible, arranged in suites.

For the safety of those on board, watertight subdivision is provided by a cellular double bottom, 5 feet 6 inches deep, extending the full length between peak bulkheads, as well as by seven transverse watertight bulkheads. Ballast is provided for in the cellular double bottom, which is subdivided into tanks aft for the storage of fresh water, while forward the space is devoted to the storage of fuel oil.

Hull Construction

The vessel is constructed on the ordinary transverse frame principle—10-inch channels being spaced 28 inches on centers in general, except somewhat closer in the forehold, and in the fore and aftpeaks, where 8-inch channels are spaced 24 inches on centers. Three side stringers are fitted in the holds on either side. The floor plates in the cellular double bottom are fitted on every frame. The deck beams vary, being 8-inch channels for main deck, 7-inch channels for upper and shelter decks and 6-inch angles for the bridge deck, fitted to every frame, while in the bridge deck house 4-inch angles are spaced 30 inches on centers.

Two rows of wide-spaced pillars and girders are adopted in holds on the main deck and on the upper deck aft of the passengers' quarters, but throughout the passenger quarters smaller stanchions are used. A bilge keel extends on each side for a length of 250 feet amidships.

Propelling Machinery

The propelling machinery consists of one four-cylinder, triple-expansion engine, of 8,500 indicated horsepower at 80 revolutions per minute, with cylinders 35 inches, 61 inches and two 81 inches in diameter, having a 66-inch stroke. The propeller is of the right-handed built-up type, with manganese bronze blades and a cast iron hub. The main condensers are of the independent cylindrical type.

Boilers

Steam is generated in three single-ended Scotch boilers, each 13 feet 6 inches in diameter and 12 feet long, containing about 6,000 square feet heating surface, and six Babcock & Wilcox watertube boilers, containing 22,800 square feet heating surface. The boilers are to carry a working pressure of 230 pounds per square inch, but are designed and built for 250 pounds, and operate with oil fuel, mechanically atomized, under natural draft.

The oil fuel system is of the Newport News Shipbuilding & Dry Dock Company type, which has been developed by considerable experiment at the shipyard. This system has been fitted to several of their recent ships, and has given extremely satisfactory results under both natural and forced draft.

An elaborate outfit of machine tools is fitted in the engineer's workshop, and the full complement of oil tanks for the engine room are of sufficient capacity for carrying lubricating, cylinder, refrigerating engine oils, etc., for a sixty-day run.

Auxiliaries

The auxiliary machinery consists of one centrifugal circulating pump, an independent air pump, two independent direct-acting feed pumps, two 25-ton evaporators, a distiller, feed filter and heater, bilge and ballast pumps of large capacity and general service, sanitary and various other pumps. The steering gear is of the Brown steam tiller type, and is equipped with complete telemotor control.

The ship is heated and thoroughly ventilated throughout. The system of heating is the usual two-pipe steam arrangement, with radiators in the social hall, ladies' lounge and writing room, while in the dining saloon and smoking room sill heaters and seat coils are installed. Electric heaters are provided for the staterooms.

For forced ventilation, one fan supplies fresh air to the staterooms on the upper deck and another to the fruit cargo spaces. Five other fans thoroughly exhaust all foul air from galleys, toilets and cargo spaces, and serve to ventilate the dining saloon and other spaces below decks.

Electricity for lighting and power purposes is supplied by two 30-kilowatt and one 50-kilowatt engine-driven generators.

The refrigerating plant is equipped with two 10-ton refrigerating machines with all necessary piping and cold-storage rooms. Drinking water is circulated through coils to the public spaces.

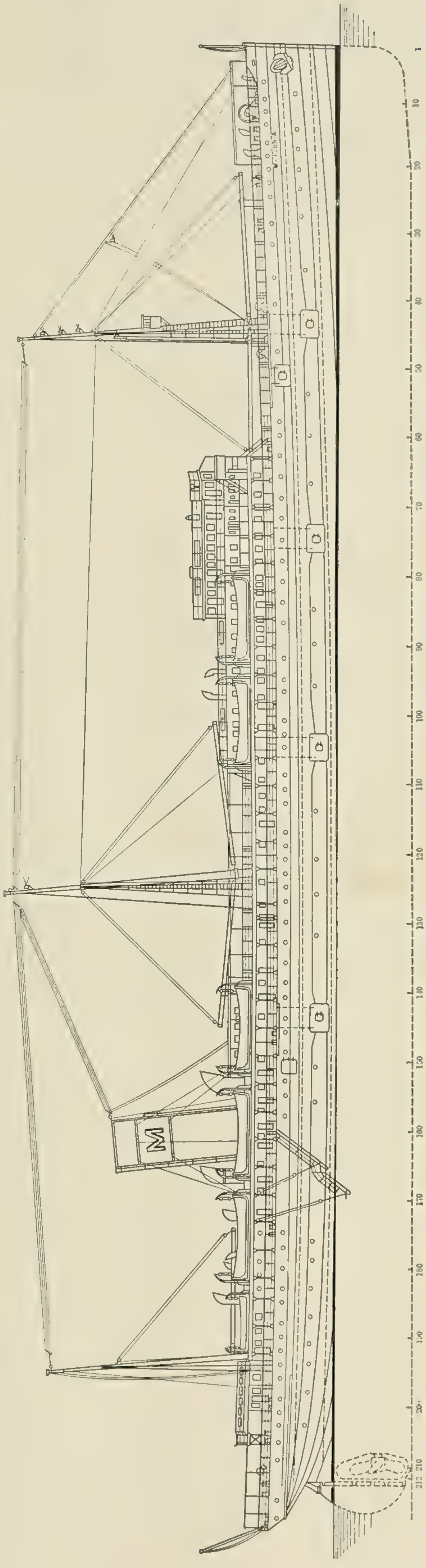
Lifeboat accommodation is provided for all on board by means of nine 28-foot metallic double-ended boats and one 28-foot wooden power boat for towing the fleet of lifeboats. In addition there will be a work boat. All are carried under Welin quadrant davits.

Cargo-Handling Appliances

For loading and discharging cargo the ship is provided with two cargo ports on the upper deck and four on either side on the main deck, as well as two cargo hatches forward on the shelter deck, and two trunk hatches located about 'midships on the bridge deck. The last two will be supplied with electric elevators for the handling of sugar cargoes.

To the foremast are attached four 8-ton booms and one 50-ton boom, to the mainmast four 8-ton booms, all for handling cargo, while to the mizzenmast is attached one 8-ton boom for handling engine room weights. The booms on the fore and mainmasts are operated by means of eight 7-inch by 10-inch steam winches, four to each mast, while the boom on the mizzenmast is operated by means of an 8-inch by 10-inch steam winch.

A powerful steam windlass with vertical capstan attached is located forward.



PACIFIC LINER MATSONIA OF 13,500 TONS DISPLACEMENT AND 16 KNOTS SPEED, BUILT BY THE NEWPORT NEWS SHIPBUILDING & DRY DOCK COMPANY FOR THE MATSON NAVIGATION COMPANY

Passenger Accommodations

About 'midships on the upper deck are located spaces for the accommodation of steerage passengers. The rooms are large and roomy, and special attention has been given to their ventilation.

Forward of these rooms and completely separate from them are first class staterooms. These, together with the ones located in the deck houses on the shelter and bridge decks, are paneled in a simple design in white. The white enameled berths, the mahogany furniture, the green carpet, all combine with the cretonne window hangings in giving a very cool and restful effect.

Wherever possible private baths are arranged, and all rooms are arranged conveniently to bath rooms. In many cases rooms adjoining are so arranged that they may be thrown into private suites.

Ten special staterooms are provided, each with its own bath and finished in an individual style of decoration. There are two suites paneled in bird's-eye maple, the long panels displaying the natural beauties of the wood to great advantage. Six other rooms are paneled in mahogany, with mahogany or silk tapestry panels varying in tone and color, and two are finished in white Colonial, one with blue and the other with pink silk tapestry panels. The special rooms are all fitted with heavy brass bedsteads and other specially designed furniture in mahogany.

In addition to these there are eight other rooms finished more elaborately than the ordinary first class staterooms, but not quite as elaborately as the special rooms.

The officers' quarters on the bridge are neatly and tastefully treated, and the captain's room forward is in close proximity to the wheel-house, which is modern in every particular and fitted with every known appliance for ship control.

Public Spaces

Well forward, and extending across the ship on the upper deck, is the dining room, arranged to accommodate 206 persons at one sitting. The style of decoration is of the late Renaissance period. There is a wainscot of mahogany surrounding the room, surmounted by a pleasing arrangement of paneling, enriched here and there by ornament in low relief. The color scheme above is carried out in a series of grays, ranging from a rich warm tone to the almost pure white ceiling. Wide-spaced stanchions are enclosed in mahogany, richly carved, harmonizing with the carved pilasters all along the walls. The beamed ceiling is supported at these columns by carved consoles, and at the forward end is the mahogany sideboard of massive yet refined proportion.

At the forward and after ends are alcoves which may very well serve for dinner parties, affording that privacy sometimes so much desired. The tables are small and arranged to allow all necessary space and to avoid the appearance of being crowded, as is generally the case on passenger vessels.

An innovation has been introduced in placing a buffet at the entrance to the dining saloon, where one may go between regular dining hours and obtain light lunch. On either side of the dining room light enters through a series of cathedral glass windows, which suffuse the light into a warm glow over the entire room. These sashes are provided with ventilating grilles, and these, together with a system of exhaust ventilation, will keep the room cool at all times.

Immediately aft of the dining saloon is the stair hall treated in modern English. This same hall is carried up for three decks, and the spacious stairways connecting same have wrought iron grilles of simple design. The walls are paneled in mahogany, large panels being used, which in their very simplicity only serve to enhance the rich grain of the wood and to emphasize the beauty of the smaller carved panels, which are fitted in combination with them. Over the stair leading to the bridge deck is the ship's clock, handsomely mounted in a large carved panel.

On the shelter deck forward of this stair hall is the social hall. The style here adopted is of the period known as Empire, with mahogany paneling and gilt ornament, enriching the warm color of the mahogany and bringing out the quiet dignity of the period it represents. The furniture, quietly designed and faithful to the period and upholstered in dark green tapestry and silk brocade completes the desired effect.

At the forward end of the social hall are alcoves filled with palms and ferns, bringing a touch of life and sunshine to those within. A pianola is also placed at the disposal of the passengers and for use in special concerts.

Just aft of the social hall, and to either side, are the ladies' lounge and the writing room. These rooms are treated in the French style prevalent in the time of Louis Seize, a style which affords an especially rich treatment of wall surfaces, with panels and the light and elegant mouldings common to the period. For the ladies' lounge the color scheme is carried out in old ivory and blue, the wall panels being of a blue figured silk tapestry. The furniture is of mahogany and upholstered in a heavier tapestry of harmonizing color, and the carpet in brown gives the sufficient background to the setting. Even the silvered lighting fixtures have been especially designed and are faithful to the period.

The writing room is similar in design and style to the ladies' lounge, but its color scheme is carried out in tones of buff and golden browns. Both rooms are separated from the social hall by French casements and are richly hung with brocaded tapestries. A number of writing desks are provided in both rooms for the convenience of passengers.

On the bridge deck, forward, and directly over the social hall, is the smoking room. Here the style followed is one of the early English styles of the fifteenth-sixteenth centuries—the Tudor gothic. The woodwork is essentially oak, stained an antique brown, and the wall panels are enlivened here and there by carvings peculiar to the period.

The idea is carried out in the arrangement also, and four alcoves are provided, with low seats facing across a heavy oak table, where one may sit, and at the alcove ends are long, narrow perpendicular windows, affording an unobstructed view out over the water. The mantel deserves especial mention. Over its mantelshelf the Royal Hawaii Coat of Arms against a robe of ermine and surmounted by the tiara is carved in solid oak, making a splendid effect. The soft tapestry window hangings add a touch of somberness to the whole, so that one unconsciously feels the spirit of the times it is intended to represent.

It has not been the aim of the decorators to impress the passenger with a false magnificence, but rather to surround him with that quiet simplicity which goes far toward making the sea voyage the delightful event it should be.

The ship as a whole may be well said to be a long step in advance of anything yet attempted for the trade in which she will engage. Her hull, machinery, cargo-handling appliances and interior arrangement and decorations each represent a vast amount of study on the part of the owners and builders, and it is confidently expected that the traveling public will rapidly discover and approve of the effort in their behalf.

The vessel is fitted with foundations for four 6-inch guns, and otherwise arranged as a vessel of the second class under the Postal Subsidy Act of March 3, 1891, to which class she is entitled on account of her size and speed.

A Course of Aerodynamics at the Massachusetts Institute of Technology.—Upon the request of President R. C. Maclaurin of the Massachusetts Institute of Technology, Boston, Mass., the Secretary of the United States Navy has detailed Assistant Naval Constructor Jerome C. Hunsaker for work at the Institute in developing courses in aerodynamics.

Design of Propellers for Geared Turbines

BY PETER DOIG

The recent remarkable results in enhanced economy, by the use of mechanical reduction gear applied to high-speed turbines, render the question of the determination of a suitable combination of turbine, gear and propeller one of immediate interest.

Geared turbine propulsion may be claimed to be well advanced in, if not beyond, the experimental stage. There are now in actual service cargo steamers, Channel steamers and warships, representing over 30,000 brake horsepower developed by steam turbines and transmitted through mechanical gearing, while over 120,000 brake horsepower is being built. The subjoined table gives the main features of some of those vessels of which particulars have been made public:

NAME.	B. H. P. One Shaft.	R. P. M. Turbine.	R. P. M. Screw.	Ratio.	Speed, Knots.
Vespasian................ Single screw.	1000	1500	75	20.0	10.5
Cairnross................. Single screw.	1600	1700	65	26.1	10.5
Neptune................. Twin screw.	3000	1200	132	9.1	14.0
Normannia.............. Twin screw.	3000	1500	300	5.0	20.0

The problem of fixing the revolutions of the prime mover and the ratio of reduction to the secondary or propelling agent is one into which a series of variables enters. These may be stated as follows:

1. The steam economy of the turbines which, within limits, is greater with higher revolutions.
2. The size (volume) and weight of the turbine resulting from the revolutions adopted for it, this being approximately inversely proportional to the square of the number of revolutions.
3. The size and weight of reducing gear, which is greater with large ratio of reduction, efficiency of transmission being practically independent of this ratio.
4. The propeller efficiency obtainable, which is generally greater with moderate than with high revolutions.

At present, for units of moderate power, the range of revolutions with mechanical gear is from about 1,500 to as high as 3,000 per minute, as, for instance, in the three 260-foot vessels for the Ceylon ferry route recently under construction. It would appear that the superior steam economy of very high-speed turbines, with the direct fuel economy resulting, will be the consideration of greatest importance in the future, and that the consequent weight-saving in main turbines, boilers and fuel should more than offset the greater weight due to gears of large reduction ratio.

One of the first points to be raised in a design is the question of subdivision of power, which will be settled by considerations of the amount to be transmitted per gear, the superior safety of multiple screws over single screw, the resulting over-all efficiencies to be expected, and the space occupied and the cost of the installation.

As a preliminary consideration of the question the propeller problem may be first investigated. The accompanying chart has been prepared from Figs. 4 and 5 of the paper in the June number of INTERNATIONAL MARINE ENGINEERING, page 243, and shows the pitch ratio, revolution coefficient, and efficiency of the best wheel of any given diameter absorbing a certain power at a particular speed; the ratio of helicoidal to disk area being .40. The curves are plotted on a base of diameter coefficient which is a function of diameter, speed and power, being:

$$C_d = \frac{D S_a}{\sqrt{\frac{H_d}{S_a}}},$$

S_a and H_d to be computed as described in the paper referred to.

The question of single or multiple screws being settled by a consideration of the factors already mentioned, it is possible by means of these curves to find the diameter of maximum efficiency, assuming the size to be unlimited. This corre-

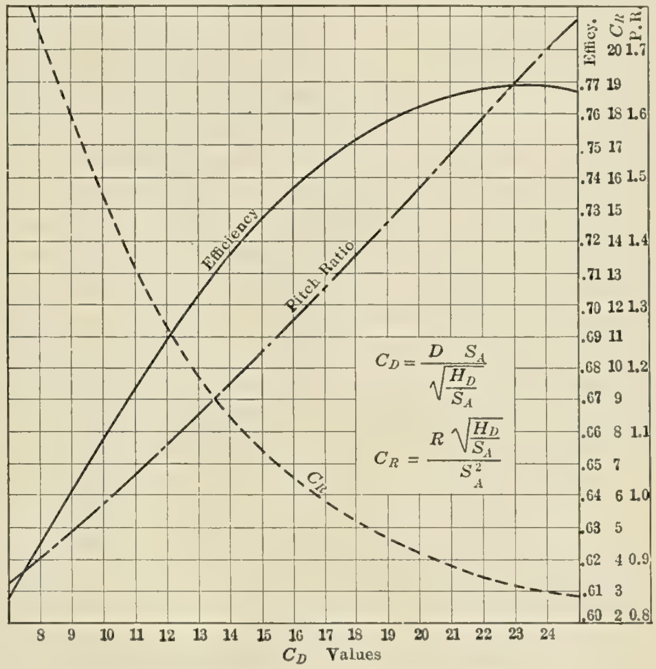


CHART FOR DESIGN OF GEARED TURBINE PROPELLERS

sponds to the C_d value 23.5, at which base value the efficiency curve reaches its highest point.

Taking the four vessels of the table above and transposing the formula

$$C_d = \frac{D S_a}{\sqrt{\frac{H_d}{S_a}}} \quad \text{into the form} \quad D = \frac{C_d\sqrt{\frac{H_d}{S_a}}}{S_a},$$

the corresponding approximate diameters of maximum efficiency result:

Vespasian: $\frac{23.5\sqrt{\frac{800}{7.5}}}{7.5} = 32.4$ feet.

Cairnross: $\frac{23.5\sqrt{\frac{1350}{7.9}}}{7.9} = 38.9$ "

Neptune: $\frac{23.5\sqrt{\frac{2850}{11.3}}}{11.3} = 33.0$ "

$$\text{Normannia:}\quad \frac{23.5\sqrt{\frac{2680}{18}}}{18} = 15.9 \text{ feet}$$

These diameters are, of course, impossibly large through restrictions of draft alone without any reference to the revolutions at which they would work.

Still considering the propeller *per se,* it will be observed from the efficiency curve of the chart that the largest possible C_d value less than 23.5 (or largest practicable diameter with a given power and speed) should be aimed at.

Regarding the problem from the propelling machinery standpoint a method of procedure might be briefly outlined as below. The arrangement of turbines generally contemplated at present is that of a high and low-pressure turbine, one on each side of the reduction gear, into which they each engage by separate pinions. It thus results that in twin or multiple screw vessels considerable athwartship space is occupied by the main propelling gear, condensers, etc., which entails, however, relatively moderate distance apart of the screw shafts, and tends to keep down the available propeller diameter.

Approximate suitable revolutions for the practicable length and brake horsepower of the turbines having been fixed on, the size of reduction gear necessary can be gaged, and hence the breadth of space required for the whole installation sketched out and approximated. With this information a layout of the shaft lines can be made and the largest possible size of the wheel obtained from the afterbody lines of the ship. This will give a certain C_d value for which the appropriate number of revolutions for maximum efficiency at that diameter can be got from the C_r value on the chart. If this number of revolutions does not agree with the originally contemplated turbine revolutions and size of reduction gear, on which the athwartship shaft spacing and consequent screw diameter were first based, the procedure will be repeated, and by such approximation the maximum practicable diameter of propeller fixed. This should generally resemble the procedure in ships of high power with somewhat restricted machinery space. Or it may be that draft of water will assign the greatest possible size of wheel. This will generally be the case in single screw ships, where athwartship space will usually be comparatively unrestricted, proper immersion at all drafts, or at least as little emergence at light draft as possible, being duly arranged for.

It is, nevertheless, possible that a still smaller propeller than that arrived at by this process might be desirable if the weight-saving through extremely high turbine revolutions and reducing gear of small reduction ratio showed itself superior in its effect on the all-round economy to that of the higher efficiency of a larger screw. From consideration of some typical arrangements the author believes that the largest wheel practicable will be a feature of the best compromise in these designs.

The utility of the accompanying diagram in the design of the various factors will be best shown by examples. The two here given represent about the extremes in types of merchant work.

Example 1.—A Channel steamer, designed to steam on trial at 20 knots, on 6,000 brake horsepower, twin screws and 1,500 revolutions per minute of turbine being adopted.

$$\text{Here } H_d = 3{,}000 \times .94 \times .95 = 2{,}680$$

6 percent being assumed lost between turbines and propeller due to gear, thrust block and shaft bearings; .95 is power factor from Fig. 2, page 242, International Marine Engineering, June, 1913.

$S_a = 20 \times .90$ (Fig. 1, page 242, International Marine Engineering, June, 1913)
$= 18.0$

$$\text{Whence}\quad C_d = \frac{DS_a}{\sqrt{\frac{H_d}{S_a}}} = \frac{D \times 18}{12.2} = 1.48D.$$

The arrangement of machinery and shaft spacing, together with the advisability of good immersion, gives 8 feet as the largest diameter desirable.

$$\text{Hence } C_d = 1.48 \times 8 = 11.84.$$

From the diagram the best pitch ratio is 1.075, giving a pitch of 8.6 feet. The value of C_r on the chart is 11.5;

$$C_r = \frac{R\sqrt{\frac{H_d}{S_a}}}{S_a^2},\qquad R = \frac{C_r S_a^2}{\sqrt{\frac{H_d}{S_a}}}.$$

$$\text{Revolutions} = \frac{11.5 \times 18^2}{12.2} = 305.$$

As 1,500 revolutions are the designed full-power speed of turbine, a reduction ratio of about 5 to 1 is necessary. The "experimental" efficiency of this wheel would be about .69 with a disk area ratio of .40, for which disk-area ratio the chart is made.

By the method described in the writer's previous paper a comparison of propeller efficiencies is possible between the above arrangement and a triple screw direct reaction turbine drive, which would be the alternative mode of propulsion.

Here the power necessary for 20 knots would be greater, owing to lower propulsive efficiency—say 6,900 brake horsepower.

H_d would be $2{,}300 \times .98 \times .94 = 2{,}120$.

S_a would be $20 \times .90 = 18$ (side screws).

The revolutions of this installation would be about 550 per minute.

$C_r = 9.3$ (Fig. 6, page 244). Projected disk area ratio $= .50$ (Fig. 7, page 244).

Helicoidal disk area ratio corresponding $= .55$.

$$\text{Diameter} = \frac{9.3 \times 10.85}{18} = 5.6 \text{ feet.}$$

Pitch $= 5.6 \times .89 \times .97 = 4.83$ feet (Figs. 5 and 8, pages 243 and 244).

Efficiency $= .64 \times .94 = .60$ (Figs. 4 and 9, pages 243 and 244).

The size and efficiency of the center screw would be about the same, so that there is a relative increase in favor of the reduction gear proposition of $\frac{.69}{.60} = 1.15$, or a gain of 15 percent.

This case is about that of the *Normannia,* where the overall superiority in fuel economy is claimed to be 40 percent, due partly to increased efficiency of turbines, partly to higher propulsive efficiency of twin screw arrangement, and partly to finer form resulting from saving in displacement consequent on a lighter boiler plant.

Example 2.—A tramp freighter; designed speed, 10.5 knots; turbine, 1,000 brake horsepower at about 1,500 revolutions per minute.

Here the draft of water would be the determining feature in fixing the diameter of the propeller. With a draft of 19 feet this would be 15 feet, which allows for considerable variations of draft, the ship being of the tramp class.

$$H_d = 1{,}000 \times .94 \times .98 = 920$$

$$S_a = 10.5 \times .74 = 7.77$$

$$C_d = \frac{15 \times 7.77}{\sqrt{\frac{920}{7.77}}} = \frac{15 \times 7.77}{10.9} = 10.7.$$

The C_r value from the chart is 13.6.

This gives revolutions $= \frac{13.6 \times (7.77)^2}{10.9} = 75$; reduction ratio being 20.

Pitch $= 15 \times 1.03 = 15.5$ feet. (Three bladed.)

The efficiency of this propeller would be about equal to one suitable for an ordinary reciprocating engined proposition. In a ship of this class the improvement in economy would be due to the superior steam efficiency and lighter machinery weights. With twin screws an improvement of about .02 in propeller efficiency could be obtained; but it is problematical if this would be worth the extra first cost and maintenance entailed.

The purpose of this paper is rather to indicate the lines on which this problem will have to be attacked, than to give a rigid method of design, which is perhaps impracticable until further practical experience has been gained. The writer trusts that this purpose has been achieved in this brief article.

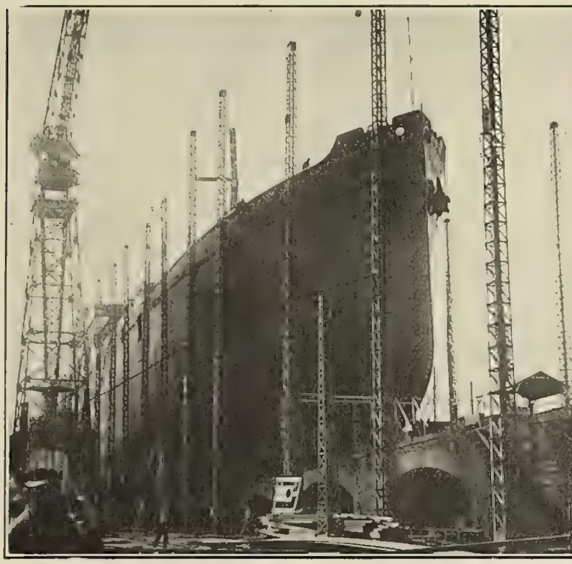


FIG. 1.—BOW VIEW OF THE CHAPLAIN

FIG. 2.—STERN VIEW, SHOWING LAUNCHING ARRANGEMENTS

Launch of the Steamer Chaplain

The largest steamer ever launched on the river Loire is the *Chaplain*, built by Ateliers et Chantiers de la Loire in their Nantes yard. The slip on which the vessel was built is 553 feet long, with a declivity of 7 percent. In front of the slip the river is only 788 feet wide, so that in order to prevent the ship from striking the opposite quay at the time of launching, a shield with an area of 431 square feet was erected across the stern of the vessel, as shown in Fig. 2. In addition to this, heavy chains were arranged, fastened to anchors securely embedded in the ground at the bow of the ship. To these cables 120 breaking ropes were fastened, each with a breaking strength of 50 tons. With these precautions, it was estimated that, although the launching weight of the ship was 3,600 tons, she would be stopped at a distance of 132 feet from the opposite quay. As a matter of fact, the stern shield proved so effective that the ship was brought to rest after only 36 of the breaking ropes were broken.

The *Chaplain* has been built to the order of the Chargeurs Réunis for their South American service. A sister ship, to be named the *Dupleix*, is also being built at the same yard, and will probably be launched about October 1. In the near future four additional steamers of this type will be built for the same service.

The main particulars of the *Chaplain* are: Length over all, 433 feet 5 inches; length between perpendiculars, 415 feet 2 inches; beam, 53 feet 10 inches; depth to spar deck, 37 feet 7 inches; draft, full load, 26 feet 3 inches; displacement at full load draft, 12,953 tons; deadweight carrying capacity, 8,650 tons; indicated horsepower, 4,000; designed speed, 12 knots.

The hull is divided into eight watertight compartments by bulkheads worked up to the main deck. The ship is also provided with a double bottom extending throughout the length of the hull, and this is also subdivided into six separate compartments.

Steam is supplied to the main engines and auxiliaries by three Scotch boilers, with a total heating surface of 8,073 square feet and a total grate surface of 183 square feet. The boilers are operated under the Howden system of forced draft and are designed for a working pressure of 200 pounds per square inch. Fuel is carried in four wing bunkers and one cross bunker, which, together with a reserve bunker, gives a total bunker capacity of 65,670 cubic feet. A single funnel carries off the products of combustion.

The main engine is of the triple expansion type with cylinders 28, 46 and 76 inches diameter, with a stroke of 52 inches, and at 74 revolutions per minute is designed to develop 4,000 indicated horsepower in order to give the ship a speed of 12 knots. The propeller is of bronze of the four-bladed type 19 feet 5 inches in diameter.

The *Chaplain* is a spardeck vessel with three complete decks worked from end to end. The four holds are of exceptional size, in order to enable the transportation of large pieces of machinery. Hold No. 1 has a cargo hatch 21 feet 7 inches by 16 feet 5 inches and is served by a 5-ton derrick. Hold No. 2 has a cargo hatch 28 feet 9 inches by 16 feet 5 inches and is served by two 6-ton and one 20-ton derricks. Hold No. 3, which may also be used as a reserve bunker, has two hatches, each 7 feet by 10 feet, which are served by two 4-ton derricks. Hold No. 4 has a cargo hatch 24 feet by 16 feet 5 inches, served by two 5-ton derricks. Hold No. 5 has a cargo hatch 19 feet 2 inches by 16 feet 5 inches, served by a single 5-ton derrick. In all, eleven steam winches are provided for the handling of cargo.

The main deckhouse is given up to passenger accommodations, while the officers' quarters are in a separate deckhouse, above which are the chart room and pilot house. Entrances to the crew's quarters and steerage passenger accommodations are through two small deckhouses on the spar deck. Amidships are two dining rooms for the steerage passengers, one seating 190 and the other 130 persons, while at the stern is a separate dining room with a seating capacity of 50. The crew's quarters are located on the first 'tween deck, while the second 'tween deck is given over to storerooms.

New Shipbuilding Berth and 250-Ton Wharf Crane at the Blohm & Voss Shipyard

On April 3 of this year the new 56,000-ton steamer *Vaterland,* of the Hamburg-American Line, was launched from the shipyard of Blohm & Voss, at Hamburg, Germany. Although this firm operates one of the largest and best equipped shipyards in existence, it was found necessary to provide a still larger berth and a new giant crane in order to build this immense vessel. We give herewith some data concerning this new equipment, which was furnished by the Deutsche Maschinenfabrik, A. G., at Duisburg, Germany, which we think will be of interest to the shipbuilding trade in general.

Fig. 1 shows the complete plant, consisting of three berths, of which the two on the left of the picture were built by the Deutsche Maschinenfabrik in 1906-7. These berths have a span of 115 feet and 203 feet respectively, and a height of 147 feet from the floor to the crane runway. The new berth on the right of the picture, below which the *Vaterland* is shown as it is leaving the berth, has a span of 288 feet at the water front and a height of 166 feet from the floor to the crane runway. This berth was built in 1910-1911. Only one-half of the new berth was finished to the full length of 1,025 feet to accommodate the *Vaterland,* the other half was finished to a length of 269 feet to provide facilities for the construction of a large floating dock which is being built at present and which can be seen in the foreground of Fig. 1. This half of the berth, however, will eventually be completed to its full length; the center columns supporting the left half of the finished berth will then be moved to the outside to make a berth of the full span without center columns, similar to the berth already completed.

The new berth is equipped with sixteen traveling cranes of 7½ gross tons capacity and sixteen trolleys of 5 tons capacity, running on sixteen separate runways; eight of the traveling cranes are equipped with standard trolleys and eight with Demag special trolleys of the revolving jib type. The cranes are so arranged that every point of the entire berth can be served by them, and when it is necessary to lift heavy loads four cranes can handle loads up to 30 tons. A transfer crane of 35 tons capacity shown on top of the left-hand berth can travel across all three berths and is used for transferring cranes to the tracks where they are most needed.

The lifting speed of the cranes, with the exception of the transfer crane, is 85 feet per minute. The longitudinal speeds are as follows: Traveling cranes, 140 feet per minute; revolving jib cranes, 200 feet per minute; 5-ton trolleys, 230 feet per minute. The jib cranes can make a full revolution in 40 seconds. The motors used in connection with these cranes represent over 2,000 horsepower, and are driven by direct current of 440 volts.

In addition to the new berth, a large 250-ton revolving wharf crane, shown in Fig. 2, was installed at the Blohm & Voss shipyard, as the old 150-ton derrick crane built some thirteen years ago by the Deutsche Maschinenfabrik was found insufficient for the heavy machinery that entered into the construction of the *Vaterland.*

With this crane the Deutsche Maschinenfabrik introduced a new design of the hammer type crane, having a movable jib which can be raised to an almost vertical position. This design was chosen on account of the ever-increasing dimensions of ships and the correspondingly increasing height of the masts. While the largest ships now in existence can pass underneath the jib in its horizontal position, it is expected that the luffing motion will be needed in the future. When it is necessary to raise the jib the main trolley is locked to the end of the boom, raised with same, and performs the same function as the top sheave of an ordinary jib crane.

The following dimensions will give an idea of the immense size of this new crane: The top of the runway rail is 200 feet above the water level, the maximum load of 250 tons can be lifted at a distance of 113 feet from the center of the crane. The capacity decreases with increasing outreaches, and is 110 tons at the maximum outreach of 174 feet. In addition to the main trolley, which runs inside of the jib girders, a revolving traveling jib crane of 20 tons capacity at 33 feet radius or 10 tons capacity at 59 feet radius is provided.

The lifting speeds of the large crane are: Twenty-six feet per minute for loads up to 50 tons, 13 feet per minute for loads from 50 to 100 tons, 6.5 feet per minute for loads from 100 to 200 tons, and 5 feet per minute for loads over 200 tons. The crane can make a full revolution in about 12 minutes and the jib can be raised to its highest position in 30 minutes. The auxiliary jib crane lifts loads up to 10 tons at a speed of 65 feet per minute, and loads from 10 to 20 tons at 33 feet per minute. The traveling speed is 160 feet per minute; a full revolution can be made in about 2 minutes and the raising of the jib requires about 3 minutes. The Leonard system of control is employed, and the motors together represent 550 horsepower.

By means of the small crane it is possible to pick up loads up to 10 tons at a distance of 240 feet from the center of the crane and deposit them 164 feet back of the center of the crane without revolving the main structure, covering a total distance of over 400 feet. The area covered by the crane is 181,000 square feet, or more than 4 acres. The arrangement of this traveling jib crane on top of the main structure is an innovation of the Deutsche Maschinenfabrik that considerably increases the efficiency of a giant crane, as it permits of the transportation of small loads at high speed, and makes it easy to handle masts and other parts of a ship located at an elevation. All of the Demag giant cranes built during the past few years have been equipped in this manner.

The crane is shown with the test load of 275 gross tons suspended from the main hook, and the *Vaterland* is lying alongside the quay ready to receive its boilers and engines. Only one man is needed to operate the large crane, and his cabin is located directly under the hinge of the big jib. When the small crane is working, the operator takes his place in the cabin arranged in front of the small jib, where he controls all the motions of the jib crane and also the revolving motion of the main structure.

In the illustration a man can be seen standing on the lower chord of the main jib, almost in the center of the crane, whose dimensions when compared to those of the crane give an idea of the tremendous size of this crane; it might also be mentioned that the two spindles that are employed for raising the jib are 19 inches in diameter and 65 feet long.

The Deutsche Maschinenfabrik enjoys an enviable reputation as builders of giant cranes and shipyard equipment, a proof of which is the fact that the Isthmian Canal Commission awarded them, through their agents, Messrs. Neumeyer & Dimond, New York, the contract for two 250-ton revolving floating cranes, which are under construction at present.

FIG. 1.—BUILDING BERTHS AT THE BLOHM & VOSS SHIPYARD, HAMBURG, GERMANY

FIG. 2.—250-TON REVOLVING WHARF CRANE, INSTALLED AT THE FITTING-OUT BERTH IN THE BLOHM & VOSS SHIPYARD

On Shipbuilding Contracts*

BY L. PESKETT

To members of the Institution of Naval Architects, the relationship that exists between the shipowner and the shipbuilder is one of peculiar interest, as the enterprise of the owner has considerable influence on the activity of the builder, the function of the naval architect being that of technical ambassador between the two. In this capacity he carries a burden of anxiety, for it is his duty to attain the realization of those Utopian ideals which the owner invariably associates with a characteristic dread of expenditure, by obtaining from the builder a ship complete in all its details, and of full value for the amount expended.

It needs but little thought to appreciate that it is in the best interests of our country to keep the cost of production within reasonable limits. When, at the launch of the *Aquitania*, the chairman of the builders' company asked for support in the formation of a combination among shipbuilders, he was appealing on behalf of a system which is the antithesis of healthy trade. The ultimate effect of any such combination is to increase the cost of production, which would be disastrous to the shipbuilding industry. The shipbuilding markets of the world are gradually altering their attitude with regard to Great Britain, and countries that at one time relied upon her to build their ships are now successfully competing with her in obtaining orders, even from British owners. The maintenance of both our shipowning and shipbuilding supremacies depends on the fundamental principle that the owner must only pay that price to the builder which is sufficient to assure him a fair and reasonable return. This is essential if the shipbuilding industry is to remain our inheritance, for every increase in the cost of production assists others in wresting it from us.

It will be well when those who control the various trade unions come to realize this important fact. Labor troubles have of late years been a source of great anxiety to shipbuilders. The time devoted by the heads of firms to the settlement of petty disputes has meant a reduction of efficiency in the conduct of their business. A solution of these difficulties might be found in the establishment of a disinterested tribunal, whose judgment in all cases should be agreed to mutually. The time at present spent in settling disputes could be more profitably employed by imitating the procedure of owners and their superintendents, who periodically hold international meetings to discuss details in connection with the work in all departments of their business.

The object of the owner when negotiating for the construction of a ship is to obtain the best revenue-producing asset it is possible to get for the sum he intends to invest. The leading shipowning companies prepare their own plans and specifications, upon which builders are invited to tender. The tenders thus received are comparable, being all prepared on a common basis.

The contract, as usually drawn up, specifies a certain fixed sum to be paid for the construction of a ship of given dimensions and speed, to be built to the requirements of the owner, and in accordance with the regulations of a particular registration society. Compare this with the procedure followed when contracting for a building.

When a building is to be erected, plans and specifications are prepared by an architect. When these have been approved, they are passed on to a quantity surveyor, who prepares a bill of quantities. Prices are then obtained for the supply and erection of the various items, based on some standard of measurement. When the building is finished the actual amount of work done is measured by the surveyor, and payment made on this assessment to each contractor at the rate previously

* Abstract of a paper read before the Institution of Naval Architects, Glasgow, June, 1913.

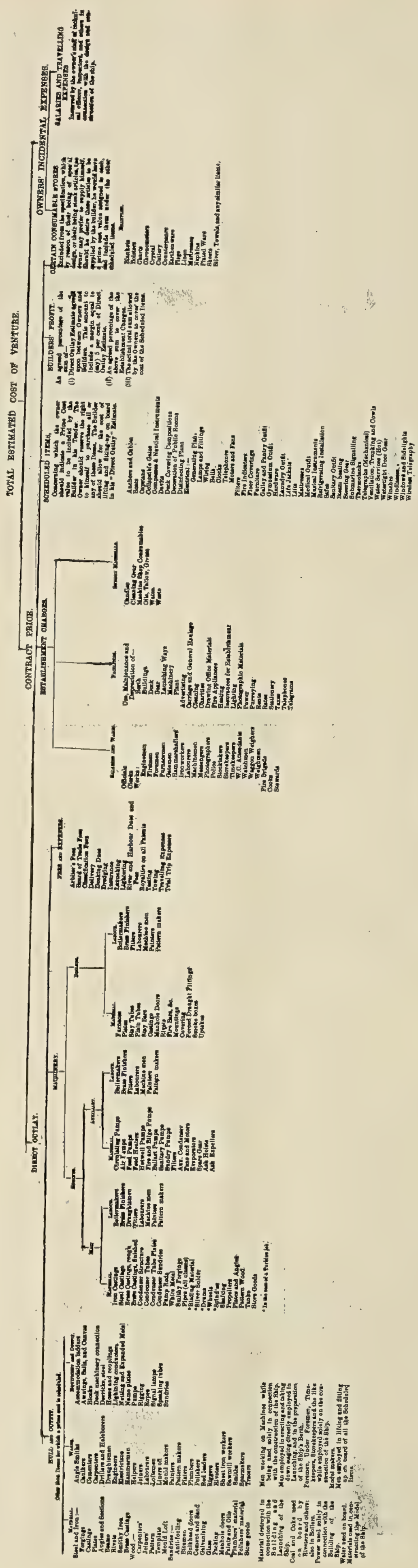


TABLE I

agreed upon. By this method the owner of the building may during the progress of the construction decide to add to, or take from, any of the scheduled items, with the knowledge that there will be a corresponding addition or reduction in the final cost.

There appears to be no reason why such methods should not be applied to shipbuilding. At the present time every firm has its own particular method of preparing estimates, but it should not be a difficult matter to arrange a suitable standardized form for computing the cost. If such a plan were adopted, the various tenders could be submitted on a standard basis. For example, all the items in connection with the cost of material and labor, establishment charges, profit and margin, could be scheduled, and a total sum defined as the maximum price which the owner would be required to pay. If the margin on direct outlay, the establishment charges and the net profit were agreed upon as a fixed sum, it would be an advantage to both owner and builder to keep the cost as low as possible. For since these items do not alter, the builder makes the same profit on a smaller turnover, while any reduction in the net cost of material and labor from the amount originally fixed reduces the cost of the vessel to the owner.

Such a system has been already carried out in practice by the Cunard Company in the case of the building of the *Franconia.* When it was arranged for that vessel to be built by Messrs. Swan, Hunter & Wigham Richardson, Ltd., a contract was made in the usual way—that is, a fixed sum was agreed upon to complete the ship in a given time. When the contract was signed, it was suggested that the ship might be built on the principle outlined above, the price already quoted being considered to be the maximum sum payable by the owner. This course was agreed to, and the result of the experiment was that upon the completion of the contract the builders handed to the owners a rebate of $97,600 (£20,000) on the sum originally fixed. This gave satisfaction to all concerned, although to the uninitiated it might be imagined that it meant a loss to the builder. The reverse was actually the case, for the original profit named remained fixed and the rebate was accounted for in the savings on material and labor mutually agreed to during the construction of the ship.

In Table I, an attempt has been made to classify under convenient headings the total cost of building a ship. It will be noticed that the Contract Price has been divided into four general sections, namely:

1. Direct Outlay.
2. Establishment Charges.
3. Scheduled Items.
4. Builder's Profit.

The Contract Price would generally include all the work under these four headings, although the decoration of the public rooms included in Section 3 might be made the subject of a separate contract, and intrusted to a firm of decorators and carried out in accordance with the designs of an architect. In addition to the Contract Price, the incidental establishment charges incurred by the owner's staff in the performance of work connected solely with the building of the ship, such as salaries, traveling, office, and other expenses, as well as the cost of any items which the owners might themselves prefer to supply in order to complete either the equipment or outfit, would have to be added, in order that the whole estimated cost of the undertaking could be ascertained.

Taking these sections in order, it will be noted that the "Direct Outlay" is subdivided under three headings, namely, hull and outfit, machinery, and sundry fees and expenses. The cost of the hull and outfit is again subdivided under headings for materials, wages, and equipment and outfit. The cost of machinery is treated similarly, engines and boilers being each separately classified under the headings of material and labor: in the case of the engines the main and auxiliary portions are kept as separate items.

Under the heading of "Establishment Charges" have been classified various salaries and facilities, together with sundry items of year which the builder is bound to provide in order to keep his establishment open, and for the use of a proportion of which payment is due to him from his customers for the time being.

The "Scheduled Items" which form the next subdivision are those usually associated with sub-contracts which may, or may not, be carried out by subsidiary departments of the builder's establishment. The interpretation of the meaning of these items is generally a matter of considerable discussion, after the signing of a contract. It is in every way preferable for the owner to indicate, and to have allotted by the builder, a prime cost amount for each item tabulated. The cost named should be included in the builder's estimate, but the owners would ultimately pay an extra, or receive a rebate, according as the net cost to the builder is more or less than the sum originally allocated.

The inclusion, or otherwise, of the cost of the "Decoration of the Public Rooms" is a matter which would be determined by the nature of the work involved. In the case of the very elaborate schemes associated with large liners, this work is undoubtedly better placed in the hands of some firm of subcontractors.

The succeeding Tables, Nos. II to V, serve to illustrate a manner in which the "Contract Price" might be determined in detail. The first sum which should be computed is the estimated cost of the builder's "Direct Outlay."

Dealing first with the cost of material, Table II outlines a method whereby the cost of the steel work and such material

TABLE II.—STEEL WORK.

Method of Taking Out Quantity.	Items. Specifying fully the nature of Material, its position in ship, etc., etc.	Rate.		Cost.		
		Material.	Wages.	Material.	Wages.	Total.
By Weight..........	Steel plates, angles, rivets, castings, forgings, pillars, rails, expanded metals, etc., etc................					
By Catalogue Prices	Bulkhead doors, manhole doors, etc., etc..........					

can be determined, which is generally done on the basis of weight. Shell and deck plating would be dealt with first, and then such other plating as occurs throughout the structure. Thereafter, and in a systematic manner, the quantities of angle sections would be taken out. An estimate would be made for the weight of various classes of forgings and castings, based on previous experience with similar ships, and this, with all other quantities, would be subsequently revised when the items came to be weighed.

Table III deals with carpenter's wood, which will for the most part be taken out on a basis of superficial feet:

TABLE III.—CARPENTERS' WOOD.

Method of Taking Out Quantity.	Material. Specifying fully class of timber, size, position in ship, etc., etc.	Rate.		Cost.		
		Material.	Wages.	Material.	Wages.	Total.
By Lineal Feet.....	Rails, sparring, etc........					
By Super. Feet.....	Decks, ceiling, hatch covers gratings, wood bulkheads grain boards, etc........					

In the two foregoing tables the cost of material is kept separate from the cost of wages. In some cases, as, for example, in the manufacture and erection of cabins and cabin framing, furniture, painting, and other work, it is a convenient and easy matter to lay down rates for combined material and labor. The method suggested in Table IV indicates such a treatment. If furniture were to be included the owner could name a price for the various items, and samples could be subsequently discussed and the price amended to suit.

TABLE IV.—JOINERS' WORK.

Method of Taking Out Quantity.	Items. Fully specified, with position in ship and description of all work to be performed on same, including painting and erecting.	Rate, Material, and Wages.	Cost, Material, and Wages.
By Lineal Feet..	Cants, head runners, architraves, cornices, moldings, rails, etc., etc........................		
By Super. Feet..	Framing, ceilings, etc..........		
By Number Off.	Window boxes, beam casings, pillars, pilasters, doors, ladders, etc., etc................ Furniture in detail:— Sofas, toilet tables, night toilets, etc., etc..............		

As another example, Table V illustrates briefly the method of determining the cost of plumber's material:

TABLE V.—PLUMBERS' WORK.

Method of Taking Out Quantity.	Items. Fully specified, with position or use in ship.	Rate.		Cost.		
		Material.	Wages.	Material.	Wages.	Total.
By Lineal Feet.....	Piping (all classes)........					
By Weight.........	Couplings, bulkhead connections, cocks, scupper heads, rough castings, etc., etc...............					
By Number Off.....	Bends, traps, etc.........					
By Catalogue Prices	Various patent articles. ...					

All the foregoing tables are intended to serve merely as indications of method, and should not be taken to represent a finished scheme. In the limits of such a paper as this no other treatment is possible, and an enormous amount of detail must necessarily remain undiscussed.

In some such perfectly feasible manner the whole cost of material alluded to under the heading "Direct Outlay" could be estimated, and a joint agreement come to with regard to the net sum involved.

The amount due for wages would then be taken out on the basis customary in the district. This can only be done after the amount of material has been determined. In such cases as those alluded to in Table IV no sum would be involved under this head, as the costs are derived on a basis which includes wages. The wages included under "Direct Outlay" are those of workmen directly employed in the construction of the ship, or working on machines while these are being used solely in this connection.

To an estimate such as this, it will be generally conceded that a positive margin of, say, 5 percent should be added, after a careful computation of the actual amount has been agreed to, in order to allow for errors and omissions. This margin should be added in when defining the cost of the "Direct Outlay."

A sum having been agreed upon as representing the Estimated Direct Outlay upon the ship, the Establishment Charges can be settled. These can be regarded as dependent upon the Direct Dutlay, and it will be reasonable to assign for them a sum which is a certain agreed percentage of this amount. What percentage is actually to be taken must depend on the nature and amount of work to be performed, for it is easy to see that establishment charges may be greatly increased if any special facilities, such as additional cranes, piling and dredging, are required to carry out the work.

It is now possible to sum the three following quantities, namely: (*a*) The estimated direct outlay; (*b*) the establishment charges (a percentage of the direct outlay); and (*c*) the sum assigned by the owners to cover the cost of certain scheduled items, which sum the builder has to include in his estimate. The builder's profit is defined as some agreed percentage of the sum of the three items above. The exact percentage having been agreed upon, the contract price is fully determined.

The progress of the transaction should be watched by an auditor, whose function should be to ascertain and certify the amount actually expended by the builders, and to determine the interest; as well as by a quantity surveyor, who would become responsible to builder and owner for the measurement of quantities.

The actual sum to be paid to the builders, as opposed to the Contract Price, will be the sum of the four following quantities: (*A*) The actual certified amount of the direct outlay, provided always that this amount is not greater than the estimated sum (*a*); (*B*) the actual sum named above to cover establishment charges, namely (*b*); (*C*) the actual certified cost of the scheduled items; and (*D*) the actual sum named as the builder's profit, and of these (*B*) and (*D*) will remain as originally arranged. The cost under heading (*A*) will be revised in agreement with the investigations of the auditor and the quantity surveyor, and if, after investigation, the sum of the costs under this heading (*A*) is found to be less than the amount of the original estimate, the balance would be returned as a rebate by the builder to the owner.

Section (*C*) must be revised, and should the cost under this section exceed or be less than the scheduled amount, an adjustment would be made.

With reference to the method of payment, an agreement is generally entered into between the owners and the builder, in which the former undertakes to pay to the latter certain definite percentages of the contract price upon completion of various stages in the ship's construction, a certain final instalment being reserved until some period after delivery.

In the case of a big undertaking where the builder would be called upon to make exceptional outlay before the instalments reached him, and where the owner might have difficulty in laying his hands upon the necessary amount when the time for payment came, it might be desirable that an arrangement should be entered into whereby the owner could deposit with the builder a certain proportion of the money which would be due for payment in connection with the forthcoming instalment.

It is apparent that such a mode of contracting as is suggested in the foregoing remarks will stimulate the business capacity of the builder. The amount of profit and the amount paid to cover establishment charges are assured to him, and, consequently, it is to his interest to exert himself to keep down the actual charges. His risks are mainly taken when he is agreeing to contract rates for wages, but it is in his best interests, as well as in the interest of the country, that the cost of production should be kept as low as is reasonable if contracts are not to be placed elsewhere, and, consequently, a scheme which enforces him to constant activity in this respect is fundamentally sound.

The cost of meeting the requirements of post-contract legislation is obviously the subject of an extra-contract agreement between owner and builder.

Both of the above are risks which have not embarrassed the successful working of such a system as has been outlined in the case of the building trades, or on those occasions when it has been applied successfully to the building of ships within the author's experience.

Official Trials of the French Battleship Courbet

The battleship *Courbet* is a sister ship of the *Jean Bart*, described on page 288 of the June, 1913, issue of International Marine Engineering. The *Courbet*, however, is fitted with Niclausse watertube boilers, whereas the *Jean Bart* was fitted with Belleville boilers. The main particulars of the boilers of the *Courbet* are:

Number of boilers	24
Total grate surface	2,035 square feet
Total heating surface	66,306 square feet
Working pressure	256 pounds
Number of elements	374
Number of tubes	9,724
Length of tubes	7 feet 11 inches
Inside diameter of tubes	3 1/16 and 2 15/16 inches
Outside diameter of tubes	3 5/16 inches
Mean diameter of funnels	10 feet
Height of funnels	65 feet 8 inches

Preliminary trials of the *Courbet* were started on May 20, after the vessel had been placed in drydock and the hull had been cleaned and painted. The following month the vessel was sent to England with the President of the Republic on board, and the final trials were not carried out until July, and as there was no opportunity to dock the vessel and clean the hull again, the results obtained from the final trials were quite different from those obtained from the earlier trials.

Six-Hour Endurance Trial, May 20—

Number of boilers in use	12
Pressure at steam chest	35 pounds
Vacuum of condenser	19.2 inches
Number of revolutions	183.3
Mean speed	13.1 knots
Consumption per hour	5 tons, 970 pounds
Consumption per mile	901 pounds

Ten-Hour Full-Speed Trial, May 28—

Boilers in use	24
Pressure of boilers	249 pounds
Pressure at steam chest	152 pounds
Vacuum	28.4 inches
Brake horsepower	25,540
Revolutions per minute	290
Mean speed	20.803 knots
Contract speed	20 knots
Consumption per hour	23.569 tons
Consumption per mile	2,495 pounds
Consumption at 20 knots, as per contract	2,646 pounds

Twenty-Four-Hour Trial, July 1 and 2—

Boilers in use	22
Pressure at boilers	229 pounds
Pressure at steam chest	87 pounds
Vacuum	28.84 inches
Revolutions per minute	256
Mean speed	18.078 knots
Total consumption per hour	13.495 tons
Consumption per mile	1,660 pounds
Consumption per mile, as per contract	1,808 pounds

TWO VIEWS OF THE FRENCH BATTLESHIP COURBET TAKEN AT THE TIME OF HER OFFICIAL TRIALS

Three-Hour Full Steam Forced Draft Trial, July 9—

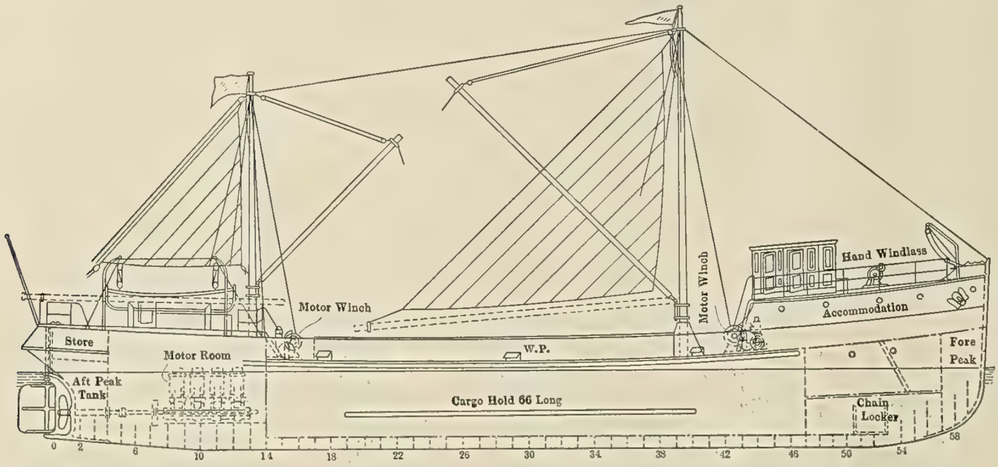
Boilers in use	24
Pressure at boilers	238 pounds
Pressure at steam chest	169 pounds
Vacuum	27.60 inches
Revolutions per minute	296
Mean speed	20.737 knots
Total consumption per hour	29.562 tons
Contract consumption per square foot of grate at 20-knot speed	32.8 pounds
Consumption on trial at 20.737 knots	32 pounds
Consumption per mile, as per contract, for 20-knot speed	3,334 pounds
Consumption per mile on trial for 20.737-knot speed,	3,157 pounds
Air pressure in boiler rooms	0.88 inch of water

Six-Hour Endurance Trial, July 16—

Boilers in use	6
Pressure at steam chest	26 pounds
Vacuum	30 inches
Revolutions per minute	127
Speed	9.396 knots
Total consumption per hour	3.149 tons
Consumption per mile	740 pounds
Consumption per mile, as per contract	750 pounds

Motor Coaster of 400 Tons Deadweight Carrying Capacity

An interesting vessel which recently passed through her official trials is the 400-ton D. W. carrier *Innisshannon,* built for the Coasting Motor Shipping Company, of Glasgow, by Messrs. William Chalmers & Company, of Rutherglen. She is the first of four vessels for same owners, and is 115 feet between perpendiculars by 21 feet 6 inches beam by 10 feet 6 inches molded depth, and is designed to take her cargo on a draft of 9 feet 6 inches. While she is generally similar to the usual steam coaster in size, the *Innisshannon* has, nevertheless, one or two rather distinctive features. She has a single cargo hold amidships, and to allow of long-length cargoes being carried the hatchway is some 44 feet in length by 14 feet 6 inches in width.



THE FIRST OF FOUR 400-TON MOTOR COASTERS BUILDING FOR THE COASTING MOTOR SHIPPING CO. OF GLASGOW

The machinery space is aft, and here is installed a four-cylinder 220-brake horsepower Beardmore direct-reversible hot-bulb engine of the solid injection type. This engine, it is interesting to note, is the highest powered semi-Diesel to be built in Britain. Fuel to the extent of 2,800 gallons, or sufficient for three weeks' running, is carried in tanks situated in the engine-room. In the way of auxiliary machinery, there is an 8-brake horsepower Coats single-cylinder air-compressing and pumping set. Compressed air is used for starting up and maneuvering, and this is stored in two large reservoirs 6 feet 6 inches long by 3 feet diameter. For working the cargo, there is a two-ton Clarke Chapman motor winch at the mainmast and a one-ton Scandia motor winch at the mizzenmast.

A notable feature about the vessel is that the quarters for both officers and crew are situated forward, as also are the chart house and captain's cabin, which are in a small deckhouse on the forecastle deck. *Innisshannon* will be used in the general coasting trade, and is expected to attain a speed on load draft of about 8¼ knots. She has been constructed to the British corporation's highest class.

On a series of runs over the measured mile on light draft, *Innisshannon* attained a mean speed of 9.16 knots.

Motor Tank Ship Wotan.—The largest marine Diesel engine as yet installed in an ocean-going vessel is the 2,000-horsepower Carels six-cylinder, direct-reversible, two-cycle motor, built by the Reiherstieg Schiffwerft und Maschinenfabrik, of Hamburg, for the German-American Petroleum Company, and installed in their new tank ship *Wotan,* now on her maiden voyage to New York. The engine has cylinders 23½ inches diameter and 43¼ inches stroke, and is operated at about 90 revolutions per minute. The *Wotan* is 404 feet long, 52 feet 3 inches beam, 29 feet 6 inches depth, with a full-load draft of 23 feet. Her carrying capacity is 6,780 tons of oil in addition to 900 tons of bunker oil and 100 tons of water, making in all 7,780 tons. Sufficient fuel can be carried on this vessel for a voyage of 30,000 nautical miles. The auxiliary machinery on the vessel conforms in the main to the general practice in Carels Diesel-engined ships.

Declaration of Principles by the Business Press of America

The Federation of Trade Press Associations in the United States in eighth annual convention assembled at the Hotel Astor, New York, Sept. 18-20, 1913, made the following declaration of principles:

1. We believe the basic principles on which every trade paper should build is service—service to readers and service to advertisers, in a way to promote the welfare of the general public.

2. We believe in truth as applied to the editorial, news and advertising columns.

3. We believe in the utmost frankness regarding circulation.

4. We believe the highest efficiency of the business press of America can be secured through circulations of quality rather than of quantity—that character, and not mere numbers, should be the criterion by which the value of a publication should be judged.

5. We believe in co-operation with all those movements in the advertising, printing, publishing and merchandising fields which make for business and social betterment.

6. We believe that the best interests of manufacturers, the business press and consumers can be advanced through a greater interchange of facts regarding merchandise and merchandising, and to this end invite co-operation by manufacturers and consumers.

7. We believe that the logical medium to carry the message of the manufacturer directly to the distributor and the user is the business press.

8. We believe that while many advertising campaigns may profitably employ newspapers, magazines, out-door display, etc., no well-rounded campaign seeking to interest the consumer or user is complete without the business press.

9. We believe in co-operating with all interests which are engaged in creative advertising work.

10. We believe that business papers can best serve their trades, industries or professions by being leaders of thought; by keeping their editorial columns independent of the counting room, unbiased and unafraid; by keeping their news columns free from paid reading notices and puffery of all kinds; by refusing to print any advertisement which is misleading or which does not measure up to the highest standards of business integrity.

Wreck Statistics for 1912

The statistical summary of vessels totally lost, broken up, condemned, etc., now published by Lloyd's Register, shows that during 1912 the gross reduction in the effective mercantile marine of the world amounted to 720 vessels of 748,965 tons, excluding all vessels of less than 100 tons. Of this total, 379 vessels of 572,745 tons were steamers, and 341 of 176,220 tons were sailing vessels. These figures are lower than those for 1911 by 135,878 tons (47,007 tons steam and 88,871 tons sail).

One of the most common terminations of a vessel's career is by breaking up, dismantling, etc. (not in consequence of casualty). The amount of tonnage so dealt with in 1912 was 157,641 tons, this being 97,876 tons less than that for 1911. conclude the existence of vessels. Strandings and kindred casualties which are comprised under the term "wrecked," are much the most prolific cause of disaster. To such casualties are attributable over 54 percent of the losses of steamers, and over 55 percent of sailing vessels. Cases of abandoned, foundered and missing vessels are no doubt frequently more or less similar in the circumstances of loss. If these be taken collectively, they form over 24 percent of the steamers and over 29½ percent of the sailing vessels removed from the mercantile marine during 1912, owing to casualty.

The return has been prepared in such a manner as to enable a comparison to be made between the percentages of loss suffered by each of the principal merchant navies in the world.

(Photograph copyright by N. L. Stebbins) ARGENTINE BATTLESHIP RIVADAVIA AT FULL SPEED

Nearly 23 percent of the steamers and 24 percent of the sailing vessels removed from the merchant fleets of the world in the course of 1912 are accounted for in this manner. Of the total tonnage of such cases over 38 percent is represented by United Kingdom vessels.

The number and tonnage of vessels lost, etc., during the previous ten years are as follow:

	Steamers		Sailing Vessels	
Year	No.	Tons (Gross)	No.	Tons (Net)
1902	301	408,363	571	292,327
1903	326	479,081	596	300,722
1904	344	512,879	463	225,266
1905	382	527,978	501	264,376
1906	378	509,707	567	307,105
1907	356	565,119	512	286,105
1908	382	566,487	418	242,805
1909	383	645,670	483	293,562
1910	421	667,440	442	280,250
1911	427	619,752	461	265,091

The statistical tables exhibit interesting data as to the relative frequency of the different kinds of casualty, etc., which

Trial Trip of the Argentine Battleship Rivadavia

The official builders' acceptance trials of the Argentine battleship *Rivadavia,* built by the Fore River Shipbuilding Corporation, Quincy, Mass., were carried out over the Rockland (Me.) measured mile course this month. The vessel is 585 feet long, 98 feet beam, designed for a speed of 22½ knots. The trial displacement of the ship is 27,600 tons and the full-load displacement 30,600 tons. The armament consists of twelve 12-inch guns, twelve 6-inch guns and sixteen 4-inch guns. The average of the high speed runs was slightly over 22.5 knots, the horsepower developed 39,750, and the revolutions 270 per minute. These trials were followed by gun trials, in which it was found that the structural portions of the ship withstood the shock of firing absolutely without injury. Further trials, consisting of a 30-hour run at 20 knots, a 30-hour run at 15 knots and an 8-hour run at 22.5 knots, will be conducted in the near future. The vessel will be delivered to the Argentine Government early in 1914.

McAndrew's Floating School

BY CAPTAIN C. A. McALLISTER *

CHAPTER XIV

Evaporators and Distillers

"Which one of you knows the difference between an evaporator and a distiller?" said McAndrew, at the commencement of the evening's lecture. Before any of the rest of the class could reply, the ever-ready O'Rourke blurted out, "One of 'em makes dried apples and the other makes booze."

"You are always talking about something that is most familiar to you, O'Rourke," sarcastically replied the instructor; "while it is true that 'booze' is distilled, we are dealing with water exclusively just now.

"You may remember that when we had the subject of boilers under consideration, I told you that nowadays only fresh water is used in the boilers. The steam from the engine is condensed over and over again and pumped back into the boilers; but in spite of all the precautions the engineer can take, there is more or less of the water lost on account of leakages around the boilers, at the pipe joints, and around the stuffing-boxes of the main engines and the auxiliaries. Just how much this leakage amounts to, it is hard to estimate, but a goodly supply of fresh water should be carried in the ship's tanks to make up the deficiency of feed. When that is used up, as it generally is after five or six days' steaming on most vessels, then we have to have other means for furnishing the fresh water. Of course, there is always as much salt water to be had as you may want, but the problem is to extract the solid matter from the sea water so that it will not be deposited on the heating surfaces of the boilers. For this purpose the evaporator is used, and you may as well understand that an evaporator is simply a boiler which uses steam to generate steam from sea water. The donkey boiler or one of the main boilers could be used for evaporating purposes but for the fact that the scale would be deposited on their heating surfaces, which are difficult to clean. Hence the most successful evaporator is the one that is easiest to clean. By using steam from the main boilers to generate steam in the evaporator, no fresh water is wasted, as the steam from the inside of the coils is condensed and passed back into the feed tank or condenser.

"The coils or tubes of an evaporator are usually arranged so that they can be pulled out or gotten at quite readily for cleaning purposes, for after only a day's use they are usually quite heavily incrusted with scale. Scaling evaporator coils at sea is a delightful job, and I am sure that you, O'Rourke, will be tickled to death to do your share of it."

"Huh!" said that worthy, "I have already done one trick at that business the last ship I was on. I worked so hard at it that I punched a hole through one of the coils, and the first assistant told me I was too strong for such scientific work."

"The chances are you did it on purpose to get out of work," said McAndrew, "but that shows you that care must be taken in scaling evaporator coils, as they are usually made of brass or copper, and, naturally, are as thin as they can well be made in order to better transmit the heat. The shell of the evaporator is made of steel, about the same as you would build a small boiler, only it is a good idea to add at least one-eighth of an inch to the thickness of the plate in order to allow for the excessive corrosion which always takes place around the water-line.

"There is quite a knack in running an evaporator, as you will find from experience. The principal thing to guard against is excessive foaming. If the water is carried too high in the glass, it will boil up and, mixing with the steam, will be carried over with it. For some reason the water in an evaporator foams more than it does in a boiler of the same size, hence its height must be watched carefully, and all evaporators should be fitted with baffle plates and dry pipes. If the distilled water is being run into a tank for the use of the ship, a little carelessness in allowing the salt water to lift might result in spoiling a whole lot of good drinking water.

"After the steam is generated in the evaporator, it is usually passed into the main condenser, where it is condensed into water along with the exhaust steam from the engine, and thus makes up the deficiency in the feed water."

"Where does this distilling business come in?" inquired Nelson.

"Oh, yes," replied McAndrew, "I almost forgot to tell you that on shipboard, as well as on shore, the distiller is used for drinking purposes, only that the ship's product is exclusively pure water. A ship's distiller is in reality only a small condenser, and is usually made of copper or brass; the sea water is used for cooling purposes, and, passing on the outside of a number of small brass or Muntz metal tubes, which have been carefully tinned, condenses the steam from the evaporator into fresh water, which is run into tanks and used for drinking or culinary purposes."

"I know all about the drinking end of it, but what's this 'culinary' stunt?" inquired O'Rourke.

"If you ever hung around the galley any, you must have noticed that the cook uses considerable fresh water to make coffee, soup, etc," replied McAndrew; "that's 'culinary'—perhaps I should have said 'cooking' purposes."

"Oh! I see," said O'Rourke; "the difference between 'culinary' and 'cooking' is about the same as the difference between a 'cook' and a 'chef.' "

"To return to the subject, I forgot to tell you that the feed water for the evaporator should not be taken from the sea direct, as it has to be heated up to the boiling temperature, so it is customary to take it from the discharge water from the main condenser, which has already been heated up to between 120 and 140 degrees; there is thus a considerable saving of heat units by using the discharge water instead of the cold sea water.

"Some ships have several evaporators in series, the steam in the first one being raised to 60 or 80 pounds pressure and then passed along to the next evaporator, where it is used to generate steam; the steam in the second evaporator is carried at a pressure of from 10 to 15 pounds, and this, in turn, is used to generate steam in a third evaporator, wherein the steam is sometimes at a pressure below that of the atmosphere, but it readily flows into the main condenser, where the vacuum is less. Such an apparatus is known as a triple-effect evaporator, and there is a considerable saving by such means. However, the first cost is so great that it is but seldom used.

"I must also tell you of a good wrinkle in scaling an evaporator where the coils are of the spiral type. A sudden change of temperature will tend to crack the scale, so that by a slight tapping with a wooden mallet it will drop off readily. To obtain this sudden change of temperature, the evaporator should be emptied of all water and steam turned on the coils until they are as hot as it is possible to get them. Then start your evaporator feed pump up as fast as it will run, open the bottom blow to the evaporator, and the valve connecting the evaporator to the main condenser, if there is a vacuum in it. The cold sea water will then rush in at such a rate as to give the sudden change in temperature desired. This effect can

* Engineer-in-Chief, U. S. Revenue Cutter Service.

also be brought about by heating up the coils, taking off the lower manhole plate of the evaporator, if such is provided, and then turning the fire hose on the coils."

CHAPTER XV

Electricity

"One of the most important of the auxiliaries on board a modern steamer is the dynamo for generating electric current for lighting and ventilation purposes. The study of electricity presents a very large subject in itself, but it is essential that all marine engineers have at least a fair insight into the general principles involved. I will therefore give you a few hints on the subject which will, I hope, be of interest and benefit to you

"In commencing my remarks on the subject, I will ask if any of you know what electricity is?"

A silence followed this question, which was finally broken by O'Rourke, who said, "I did know once, but I have clean forgotten it."

"Too bad! Too bad, entirely," said McAndrew; "what a loss to the scientific world! To think that you once knew the mystic key to this great question which no living man has ever solved, and that you have forgotten it! You certainly should be punished for such monumental carelessness in keeping from the public the true answer to this hitherto unanswered problem. Well, we will have to continue in our ignorance, and although no one but O'Rourke has ever really known what electricity is, we, in common with all others, will have to devote our attention to studying its effects.

"The name 'electricity' comes from the Greek word 'electron,' meaning amber, as it was from rubbing this material with a catskin that the phenomenon was first noticed. There are three principal ways of generating this current, as it is generally termed. The first might be termed 'frictional electricity,' as it is generated by rubbing such substances as glass and silk together; you may also have noticed its effect by scuffing your feet on a woolen carpet and then touching some metal, such as a gas jet or brass bed, when you can generally see, hear and feel a slight electric shock. This method of generating electricity is not, however, used practically.

"The second method might be termed 'chemical electricity,' from the fact that a current is set up by immersing two different metals in a chemical solution. Copper and zinc are most commonly used, as it is found, when these metals are immersed in a mild solution of sulphuric acid, a pronounced flow of electricity is set up between them. This combination is known as a cell.

"A number of cells form a battery, and electricity from such a source is largely used for operating telegraph lines, alarm bells, etc. What are known as 'dry batteries,' wherein electricity is formed by the chemical decomposition of zinc in the presence of carbon surrounded by a paste made of plaster, flour or chemicals, are particularly useful on shipboard, as there is no liquid to be spilled by the rolling of the ship.

"The third method of generation might be termed the 'magnetic system.' You all know of and have played with the ordinary toy horseshoe magnet. The two ends of a magnet are known as 'poles,' and you no doubt have observed that there is an unseen force acting between these poles, sufficiently strong to attract or pick up small pieces of metal, and that it is particularly strong in picking up iron or steel. This ability of attracting pieces of metal is attributed to what are known as 'lines of magnetic force' which exist in the magnet. Some of the early experimenters discovered that if certain combinations of wires were revolved between these poles of a magnet —or the 'magnetic field,' as it is called—a current of electricity would be set up. Proceeding on this principle, the modern dynamo has been evolved. I will not attempt to mystify you by going into the theory of how this is done, as I feel quite sure that after I had finished you would probably have a hazier idea than you had before, so I will confine my remarks to some of the practical things which you should learn about the subject.

"This 'magnetic system' of producing electricity is used almost exclusively for all lighting and power purposes. The modern dynamo for producing current is to all intents and purposes a large magnet, and the bunches of wires revolving between its poles, and hence cutting the 'lines of force,' is known as the 'armature.' The current is collected by what are known as 'brushes,' generally blocks of carbon, held against the revolving metal.

"I do not expect you to grasp the idea of electricity immediately, as very few people do, but it will probably help you somewhat to compare it with water in a pipe system. In such a comparison we will consider the dynamo as a pump forcing water through a continuous line of pipe of varying diameter, according to the flow desired. We will suppose that the main leading away from the force pump is divided up into several branches, and that from each of these branches there are numbers of small spigots from which the water is being drawn. We all know that no water will flow from the outlets unless a pressure is put on by the pump. We also know that this water is being used at the various outlets, and that we can determine how many gallons per minute is being used if we so desire. You can also readily understand that the water will not flow through the pipe line as readily as it would if simply pumped overboard directly from the discharge valve, on account of the friction of the water as it slides or flows over the inner surfaces of the pipes. Now we must imagine that electricity is being used instead of water. The wires, proportioned according to the amount of flow required, take the places of the pipe and its branches. The electric lights, distributed along the branches, take the places of the spigots in the pipe line."

"The pressure of the water corresponds to what is known as 'electro-motive force' for electric currents, and the unit is known as the 'volt.' Thus we have on the switchboard of all electric plants a 'voltmeter,' which corresponds to the pressure gage in a pipe line; in other words, we read the electric pressure from the voltmeter, and it is well to note that the standard pressure for lighting currents on shipboard is 110 volts.

"The resistance to the flow of water through pipes corresponds to the resistance of the flow of electricity through wires, and the unit of this resistance is called an 'ohm.'

"The rate with which water flows through a pipe in a given time is expressed in so many gallons per minute; in electricity the rate of flow is expressed in a unit known as an 'ampere,' which means the amount of current produced by a pressure of one volt acting against a resistance of one ohm.

"Electric power, like mechanical power, must take into consideration the element of time, and the unit of this kind of power is known as the 'watt,' which is the power produced by a current of one ampere at a pressure of one volt for one second."

"Where do they get all these funny names like volt, ampere and ohm?" inquired Pierce.

"They are derived from the names of the early scientists who studied this subject, and in this way their fame will be handed down to future generations. Volt comes from the Italian named Volta, who was an early experimenter in the subject. Ampere was another early scientist, and you ought to know that Watt was the inventor of the steam engine. If you had been around in those days, and made the experiments, the unit of pressure might have been a 'pierce' instead of a 'volt.'"

"I'll bet," said Smith, "that the unit of resistance or friction would have been an 'O'Rourke' if he had been around in those days."

"One thing sure," replied McAndrew, "the unit of work—'ampere'—would never have been displaced by anything that sounded like an 'O'Rourke.'

"The 'watt' is a much smaller unit than the horsepower, and, in fact, it takes, theoretically, 746 watts to equal one horsepower. That doesn't mean that a one-horsepower engine would produce that many watts, as there are too many losses between the two, but it is known as the theoretical equivalent. In speaking of the rated power of a dynamo or generator, the general term is 20 K.W., 50 K.W., etc., as the case may be. The K. means kilo, the Greek word for one thousand, so that a 20 K.W. machine means one that is capable of producing 20,000 watts.

"To utilize electricity for lighting purposes, it was necessary to invent an electric lamp, and this fell to the lot of Edison, an American inventor, who, after many months of experimenting, found that a filament of carbonized bamboo, placed inside a glass bulb from which all the air had been exhausted, would heat up to an incandescence when an electric current was passed through it. If the air is not exhausted from the bulb, the oxygen in the air would cause combustion, which would burn up the filament almost instantly. Many metallic substances are now used for filaments, and are known as 'tungsten,' 'mazda,' 'tantalum,' etc. These are much more efficient than the old-style carbon-filament lamps, that is, they give much more light for the same amount of current used. The ordinary carbon-filament 16-candlepower lamp is generally used on shipboard; this lamp requires about ½ ampere of current or 55 watts. If we know the voltage of a current and the amperage, how do we tell how many watts will be used?" asked McAndrew of the class.

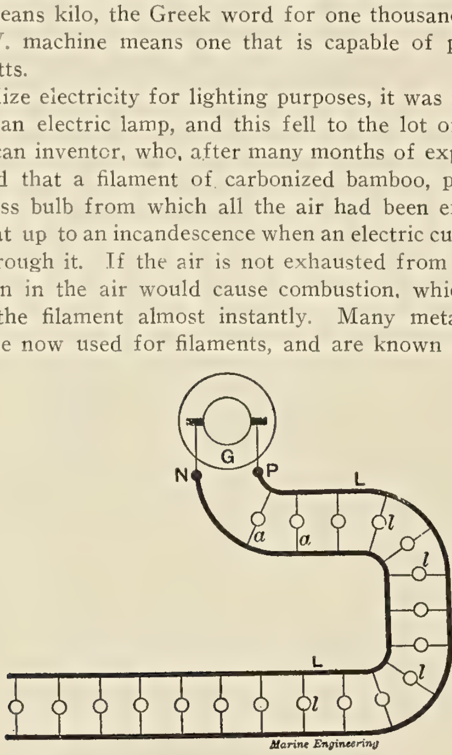


FIG. 24.—DISTRIBUTION IN PARALLEL

"Wait until you get the bill from the electric lighting company," suggested O'Rourke.

"You can't be too sure of that," replied the instructor, "as most people have an idea that gas bills and electric light bills are not made out on a strictly scientific basis. The right way to ascertain that fact is to remember that the watts are equivalent to the volts multiplied by the amperes. In this case we have 110 x ½, which equals 55. If we were using 20 amperes of current at a pressure of 10 volts the result would be 20 x 10, or 200 watts.

"An ordinary 16-candlepower lamp, using 55 watts of current, will require, on an average 1/10 horsepower at the generating engine, so I want to impress upon you the importance of turning off electric lamps which are not needed in any part of the ship, as they soon eat into the coal pile to a considerable extent, for every hour that a 16-candlepower lamp is burned there is nearly a pound of coal used under the boilers.

"I want to call your attention to the instruments used on the switchboard, which is the name of the apparatus by means of which the current is distributed. The whole electric light system is divided up into circuits or branches, corresponding to the different parts of the ship. For example, there is usually a complete circuit for the engine room, one for the fire room, one for the social hall, etc. If these were water-pipe connections there would be a valve in the pipes at both ends of the circuit. For electricity, what is known as a switch or cut-out is used, and generally located on the switchboard. They are usually of the double pole type, that is, they cut out both the sending side and the return side simultaneously.

"Unlike water, electricity is liable to sudden fluctuations of both pressure and volume; unless some means of easement is provided, damage is liable to result to the wiring or fixtures. Hence at various points in the circuit the current is made to pass through short lengths of some fusible alloy, which, when subjected to an unusual current, melts and breaks the circuit. These are made in two types, the link and cartridge; one is a plain wire, and the other is a wire encased in a fiber tube. The action in this case is similar in effect to the blowing off of a safety valve.

"The ammeter is an instrument for indicating by a needle on a dial the amount of current being used, which varies, of course, with the number of lights and fans in use.

"The voltmeter, or pressure gage, has the same function as a steam gage on the boiler.

"The rheostat is an instrument for using up surplus energy or current, and consists of a series of coiled wires which can be connected up in the circuit by moving a handle across the contact points. You probably know that when the main engine of a ship is required to run slowly, and the boilers temporarily making more steam than can be handled by the engine, it is customary to open what is known as the 'bleeder valve' from the main steam pipe, which allows the high-pressure steam to blow directly into the condenser. This is practically the same purpose for which the rheostat is used, the surplus current being dissipated by the increased resistance of the coils of wire which disposes of the electric energy in the form of heat.

"Now a word about wiring to transmit the current to the points where it is needed. As copper offers less resistance to the flow of electricity than any other metal of reasonable cost, it is used almost universally. In laying out the wiring for the ship, the sizes are determined to suit the quantity of electricity to be used in about the same manner that we would proportion piping for the distribution of steam or water. Small wires are made single, and for larger currents it is customary to use a number of small wires either parallel or laid up in the form of a cable. On shipboard it is of the first importance that the wires should be well insulated, that is, covered with a substance which prevents entirely, or to a large extent, any flow of electricity through it. The best and most used of such substances is ordinary rubber covered with braided silk or cotton to make the whole covering waterproof. Water is an excellent conductor of electricity, and hence any leakage through the covering on the wires will rapidly result in corrosion of the wires and leakage or short circuiting of the electric current. In the first marine electric installations the wires were run in wooden strips, but as it was difficult to keep them tight, the almost universal practice now is to run electric wires in iron pipes known as conduits. Porcelain is another excellent non-conductor of electricity, hence we find that material used for various kinds of electric fittings and lamp sockets.

"The wires for electric lights on ships are usually run in what is known as 'parallel,' as shown in Fig. 24.

"Each lamp, you will notice, is tapped off between the two wires, so that each will draw a sufficient amount of electricity from the main to run the particular lamp.

"Other uses than for lighting on shipboard are fan motors and winch motors."

"What is a motor?" inquired one of the class.

"A motor," said McAndrew, "is simply a small dynamo running backwards. Electric fans are driven by means of the current passing through the wire wound around the magnetic poles, which causes the armature to revolve. The fan blades are secured to an extension of the armature. If the small armature was made to revolve by an engine or other source of power, the motor would generate electricity instead of using it up, and hence become a small dynamo."

(To be continued.)

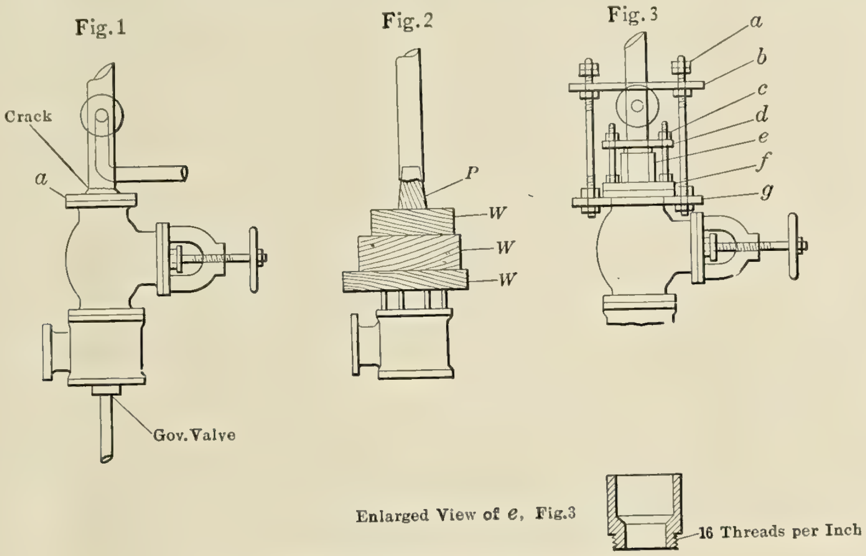
Letters from Practical Marine Engineers

Incidents Relating to the Design, Care and Handling of Marine Engines, Boilers and Auxiliaries; Breakdowns at Sea and Repairs

Burst Steam Pipe

In the September, 1912, issue of International Marine Engineering appeared a description of the methods of repairing two breakdowns which occurred in a vessel equipped with a poorly-supplied storeroom. The following is an account of the way in which a burst steam pipe was repaired in another ship which was equipped with plenty of tools and materials.

Fig. 1 represents the throttle and governor valves, which were connected to one 26-kilowatt dynamo engine and one 2½-inch steam pipe. Another pipe was branched, as seen in the sketch. It supplied steam to a smaller dynamo.



Method of Repairing a Burst Steam Pipe

At 1 o'clock in the night, while running the main engines and the big dynamo at full speed, a sudden blow of steam was heard, followed by a sudden darkness throughout the whole ship. Upon inquiry, the cause was found to be that the steam pipe burst all the way around the neck of the flange connecting the pipe with the throttle valve. (See Fig. 1.) It disabled also the running of the smaller dynamo, so candles and oil bunker lamps were lighted.

But it was not altogether pleasant to stand night watches with that kind of light in a fairly big engine room, which is usually semi-dark at daytime, with the main engines running at full speed ahead and auxiliary apparatus here and there performing their respective duties, so we started to arrange the smaller dynamo to give us the required light temporarily.

First we removed the stop valve, together with the broken flange; then we plugged the steam pipe with wood. To have this plug securely fast several wood blocks were placed beneath it, and resting on top of the studs of the governor valve, as shown in Fig. 2. We had then all the light we wanted.

The next morning, and after a sort of a contest among the several engineers and electricians of the ship for the best idea for repairing the mishap, so as to enable both dynamos to furnish light and power for the machine shop all the time, we proceeded to carry into effect the scheme sketched in Fig. 3.

The center hole of the broken flange, now loose from the stop valve, was enlarged to 3 inches diameter, and sixteen threads cut inside. Part of one brass casting, 4½ inches diameter, was shaped in the lathe, as shown in the enlarged view of *e*, Fig. 3. This was screwed hard into the flange. Out of the remaining brass casting and one old brass flange found in the "junk pile," we made the corresponding gland (*d*, Fig. 3).

The joint of the throttle valve and the steam pipe flange was made before the breakdown by six ¾-inch bolts; three of these were removed and three studs of the required length with three nuts in each were fitted instead, so as to replace the removed bolts and drive the gland at the same time (Fig. 3, *c*). In order to prevent the movement of the steam pipe two pairs of clamps were forged from a flat iron bar ¼ inch thick by 2 inches wide. One was fitted to the neck of the stop valve (Fig. 3, *g*), and the other pair to the steam pipe, half an inch above the branching of the smaller pipe (Fig. 3, *f*). Two ⅝-inch stays (Fig. 3, *a*) were fitted afterward to hold the pipe down, and the upper nuts were slackened one turn and a half so as to allow for the expansion of the pipe.

The final result was what you might have called an expansion joint, and it proved entirely successful.

Manila, P. I. Augustus Suzara.

Unlooked-for Stresses

The writer has frequently noticed cases where unconsidered stresses have produced quite unlooked-for results. As examples, the following two recent experiences may serve as illustrations and prove of interest to other readers.

The first case which the writer has in mind is that of a cast iron paddle center which was being replaced. It is much better to make these of cast steel, as it is tougher and better able to withstand the usage to which it is subjected, but as the original center was of cast iron the new one had also to be made of the same material.

In fitting these centers they are turned to a diameter slightly less than that of the shaft, and then driven on with a 28-pound hammer, removed and the hard places in the center scraped down as indicated by the red lead bearings. Great care should be taken not to scrape away a false bearing.

It may be noted in passing that it is always advisable, in taking each bearing, to drive the center on the shaft twice, as the writer has frequently observed a difference of ¼ inch on driving it on the second time. When the job is finished and a good bearing obtained the center should still have ¼ inch to ⅜ inch to go until it is hard up against the shoulder turned on the shaft. This is to allow of being finally driven up with a "dolly" when the wheel is installed on the ship.

The center in question had been bedded in as usual and the allowance of ¼ inch for final driving on left, and then the arms were fitted and the wheel built up. On fitting the completed wheel in the ship it ran on to the shaft right up to the shoulder with the greatest of ease. The remedy was to chip ½ inch off the shoulder with a hammer and chisel and then file it up, as there was no time to remove the shaft again and do this in a lathe.

Naturally the cause of this strange phenomenon was sought after and it was suggested that the driving in of the paddle arms might have something to do with it. With this end in view wedges were driven into the recesses for the arms in the old center, the hole being carefully calipered before and after the operation. Though no actual measurements were taken, it was found that the hole was several thousandths of an inch larger after the wedges had been driven in than before, thus locating the cause of the trouble definitely in the building of the wheel.

Another case was that of a pad of a boiler stop valve. The pad, owing to some reason or other, had only been calked round half its circumference when the writer commenced to face up the pad and bed in the valve. The job was almost finished when a calker was sent to finish calking the pad. This he did, and on next trying on the valve we found that at the part of the circumference which he had just calked the pad had been raised up for about an inch in from its edge a distance of about a thirty-second of an inch.

This could quite easily have been avoided by calking the whole of the pad at one time, but the example serves to illustrate the forces brought into play in engineering, which are impossible to estimate.

Glasgow. "Ison."

Notes on Lubricating Oils

As the subject of lubricating oils is of great importance to marine engineers the following notes and simple tests may be of interest. To make a chemical analysis of the oil as it comes on board is, of course, impossible, involving, as it does, special apparatus and the expenditure of a good deal of time, hence only such simple tests are given as can be performed without spending much time on the job.

There are three classes of oils:

(1) Mineral oil.
(2) Animal oil.
(3) Vegetable oil.

And the chief properties which determine their suitability for lubricating purposes are: 1, the viscosity; 2, freedom from a tendency to gum; 3, freedom from acid. In some cases the flash point has to be taken into account, but this will be gone into later.

The value of an oil as a lubricant depends solely on its film-forming capacity, *i. e.*, its capability of maintaining a film of oil between the bearing surfaces. Film-forming capacity depends on the molecular cohesion, and also to a certain extent on the viscosity; but it must not be inferred from this that the oil of highest viscosity is the most suitable lubricant. To keep a bearing running cool it must have a good, durable oil film between the bearing surfaces, and the oil of lowest viscosity which will retain this oil film is the most suitable one for the purpose. Higher viscosity than is necessary to retain the oil film will result in a waste of power, due to the expenditure of energy necessary to overcome the internal friction of the oil itself. The viscosity of an oil for use in a certain bearing is dependent on the load carried; for example, a high-speed, light machine requires a thin oil, while a slow-running, heavy-duty machine is best suited with a thick oil, the thin oil having insufficient "body" to keep a good oil film between the bearing surfaces, and hence the bearings will heat up. Vegetable or animal oils are fairly suitable for external lubrication, but are apt to contain acids, due to the decomposition of the oil.

The following is a simple test for the viscosity of an oil: An ordinary glass burette fitted with a stop-cock is obtained and filled with water. The water is allowed to drip slowly through the tap and the number of drops per minute noted. The water is then removed, and without altering the setting of the stop-cock a sample of the oil under test is substituted. A similar test is then made. By this means some idea of the relative viscosity of oil may be obtained. The test is near enough for most practical purposes, but it must be remembered that the viscosity varies with the temperature.

For general purposes the following simple test is useful, but it must be remembered that it is not sufficient to judge a sample on the result of this test alone. Pour a few drops of each sample onto an inclined plate; the oil which remains fluid longest and runs farthest is the best.

The viscosity of oil can be varied by the addition of foreign substances, such as wax, resin, resin oil, etc. By adulterating a poor quality of mineral oil with resin or resin oil the oil may be made to resemble the superior quality, as regards density, viscosity, color and general appearance. The following two tests will serve to indicate whether an oil has been adulterated or not: Take a quantity of the oil and heat to a temperature of from 400-500 degrees F. If any fatty oil is present it will decompose before this temperature is reached, and its presence will be indicated by a bad smell. Another test for the detection of adulterants in mineral oil is to mix a portion of the sample with an equal quantity of fuming nitric acid. If at the end of a few hours the sample is still fluid it has been adulterated, and should not be used.

For internal lubrication only pure mineral oil of good quality should be used. Vegetable or animal oils are unsuitable, owing to the fact that they decompose at high temperatures, forming acids which are injurious to metals. Soot is also liberated, and the hard particles of carbon abrade bearing surfaces considerably. Mineral oil does not suffer from these drawbacks, as it has no effect on metals with which it comes in contact, and when vaporized does not decompose. If it is not wished to vaporize the oil it should be seen that its flash point is above the temperature of working. There are two tests for flash point: (1) the "closed" test; (2) the "open" test. The closed test requires special apparatus embodying a container to hold the oil fitted with a lid, which on being opened automatically depresses a small gas jet into the mixture of oil, vapor and air. The oil is heated gradually and the flame depressed into it at regular intervals of time. When an explosion is obtained the temperature is noted on a thermometer. An approximation to the true flash point may, however, be obtained by means of the "open" test, which simply consists in placing some of the oil to be tested in a suitable vessel and heating gradually, at the same time passing a flame over the surface of the liquid. A small high-temperature thermometer is, of course, placed in the oil to note the temperature at which the vapor ignites.

To find whether an oil contains an appreciable amount of acid, litmus may be employed

In conclusion, it may be noted that the following oils corrode the metals mentioned opposite them:

Tallow oil—Iron and copper.
Seal oil—Copper.
Whale oil—Lead.
Lard oil—Lead.
Sperm oil—Lead and zinc.
Rape oil—Copper.
Cottonseed oil—Tin.

J. H. G. M.

Leak Caused by Careless Boiler Maker

A bad case of pitting was found on board a steamship at the front end of the bottom of all three main boilers just above the knee plate, as shown on the sketch. A good layer of cement had been put on the inside, which lasted well until the ship came into port for repairs.

The boiler makers fitted a bent patch ⅝ inch thick over the end, as shown in the sketch, fitting bolts in places where the riveter couldn't swing his hammer. They had to cut the knee plate away to allow for the patch to fit in, which they jointed with some patent cement that proved useless after a while.

After the repairs had been made, and the vessel had been under steam three days, I had just gone down on watch one night, when one of the flat-faced Chinese firemen ran into the engine room, shouting, "Misses! Misses! too much puff! Plenty too much puff! Come! Look! See!" Well, I went to look, "see, see," as he called it, and found a great opening in one of the calked joints of a patch, as shown in the sketch. After calling the chief to see it, he went up to report to the captain, saying he would let the boiler down.

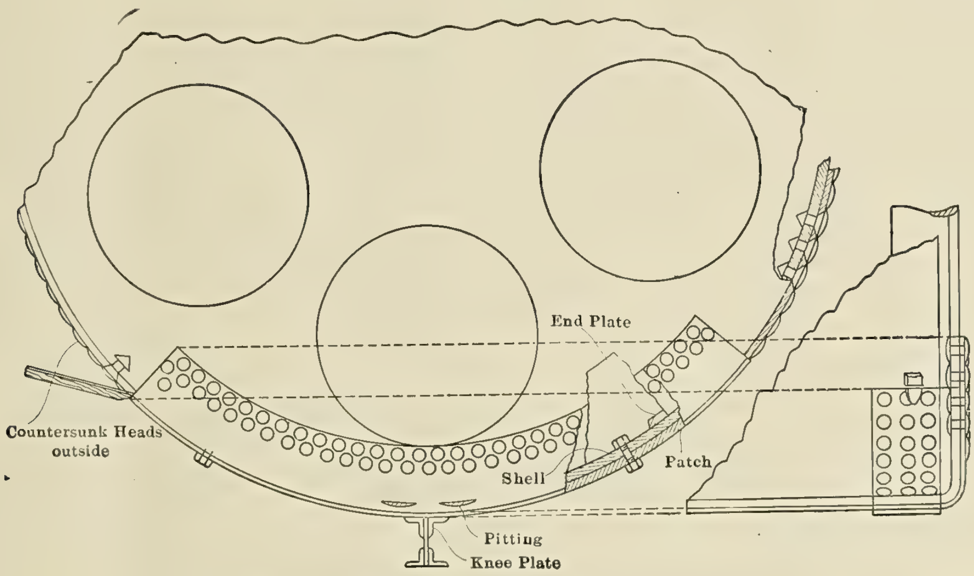
I went in the engine room to oil around, attend to matters, etc., and after a few minutes the same Oriental came in and said, "Misses, puff finish! You look, see! Yes, allight." When I got in the stokehold, I found they had sharpened the end of a piece of wood they had found about 5 feet long by 3 inches by 2½ inches, and hammered the wedge end in the blow hole, completely stopping all steam. They tried to look pleased at what they had done on their own initiative, but their faces wouldn't allow for the expression. The chief couldn't believe it would last without giving out, but it did for seven weeks. It did seem funny to us, under steam, with a great wooden chock rammed in one of our boilers.

However, when we did let the boiler down we found the end of a boiler maker's calking tool had been carelessly jammed between the patch and boiler plate and broken off, the man leaving it in without saying anything on the matter, and, of course, this piece of calking tool had blown out, causing "too much puff," as the fireman called it.

We hammered the patch up close, filled the joint with putty and recalked it.

I may say that when they had tested the boiler bottoms before fitting the patches, they found the plates pitted all in the one place, in the shape of a hollow the size of a man's hand. In some cases the plate was worn down to about one-eighth inch thick, yet 160 pounds pressure had been on the boilers the day before. To my mind, it is a good thing no heavy vibration of the furnace flues had taken place while under steam, or there might have been a serious accident. Needless to say, the boilers must have been a pretty old job to have reached that condition.

R. Stein.



SKETCH OF FRONT OF BOILER, SHOWING POSITION OF PATCH

A Reader's Comments on the Recent Contract for the Turbine Casings for the Battleship New York

It is, of course, quite possible that the current newspaper reports as to the placing in England of a contract for the turbine casings for the United States battleship *New York* may not be strictly accurate. In the press reports it is asserted in round figures that the English bid is $57,000 (£11,700) as against the lowest American bid of $160,000 (£32,800). These figures show such a surprising difference that it is certainly an interesting question to consider how such an enormous difference can be compatible with good business on either side of the Atlantic.

Work is undertaken, broadly speaking, for the three following reasons:

First, with a view of making money.

Secondly, with a view which disregards a profit but expects to make no loss. The advantage of being able to keep a well-organized force at work and not disintegrate it is an offset for lack of profit.

Third, a desire on the part of bidders to get a line on work which may be of advantage to them later. No hope of profit being entertained on the work, the loss is charged on the books to advertising, or whatever in the minds of the managers will show the loss the least conspicuously.

Now let it be understood that the standing of the New York house, as well as the English concern represented by them, is too high to admit of any supposition that the contract will not be absolutely carried out. From a pretty fair acquaintance of foundry conditions in England and the United States, it is quite impossible to lay to the cost of material any but a small portion of the enormous difference in the bids. It must, therefore, come down to considering whether the foreign firm through its greater experience in the foundry can produce with far less risk such large and complicated castings than can be done here. This, coupled with the possibility of an infinitely better system of machining the castings, would of course count toward a far lower cost than is possible in any American engineering works for the job in hand.

It might be supposed by some that the American representatives of the English firm were not thoroughly cognizant of the close and exacting inspections which all work for the Navy has to undergo, but this idea can be immediately swept aside when it is understood that they have done business with the Government for years.

It is, therefore, only fair to assume that the English firm through its American representatives understand what they are about. If they expect to make money on the contract at the prices offered, it can be but a very small amount; or they may wish to keep their organization together while obtaining future contracts; or, finally, they may want to get a large proportion of the United States work with the hope of future profits. The statement that a duty will be collected has also been considered. As to the freights, there will probably be little or no difference between those from England and the United States.

On the other hand, in the several foundries of the United States able to undertake such large castings as these casings, many difficult pieces have been produced without unreasonable loss, yet the American foundries may have perhaps allowed too large a margin of safety, which would, of course, run up the price. Just what appliances the English firm has for machining casings cannot be stated here, but from a personal observation of those in the United States used for the boring part of the work, it is safe to say they could not be worse.

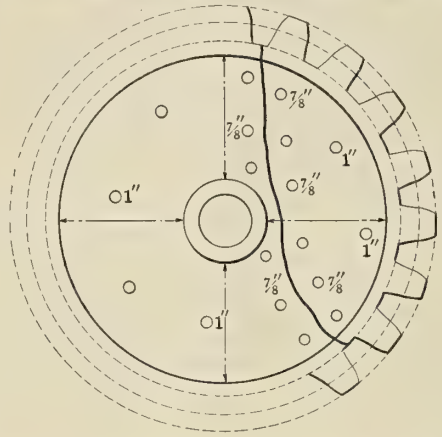
The machining of the casings is a job needing great care, but, after all, it is simply removing metal to an exact amount —no more, no less—and certainly the American machine shops have been able to do this creditably in the past. Of course, there will be the workingman's friend, raising his voice for protection for his fellow workman at so much "a profit," and there will be those who will show that every dollar sent out of the country is so much to the bad; those, too, who will be delighted that the idea has at last prevailed that an article should be bought in the cheapest market. Yet it will be interesting, indeed, to watch this contract, as it may be far-reaching in its effect by either showing that there is an absolutely absurd profit demanded by American manufacturers under the conditions of Government bids, or that our over-sea friends are running too close to the wind.

New York. W. D. Forbes.

Broken Reversing Wheel

The steamship *B*——— had her reversing engines fixed on the two forward columns, each side, her shaft being amidships. On the end of the shaft was keyed a small pinion, which worked into a gear wheel of 4 feet diameter, whose shaft passed through the column at right angles to the reversing engines, which was fore and aft. From the wheel, and connected to the arm which in turn operated the shaft to which the links were connected, was a rod, whose center was 1 foot 3 inches from the center of the wheel, giving a travel of 2 feet 6 inches. This is a general outline of the arrangement of the reversing motion; but what I have to say is in regard to the gear wheel, which was 4 feet diameter, and solid cast iron with no arms. The thickness of the body was only half that of the width of teeth and the boss. Its shaft was of steel, 6 inches diameter.

During heavy weather on one trip this wheel broke in two parts, as shown in the sketch, due to racing and extra weight thrown on it from the reversing shaft and levers. The engine had to be stopped to effect repairs; the rod was lashed down by wire rope, with the blocks in the go-ahead position. After this was done the engine was started again, while we started to patch the wheel, as there was no spare one on board. A



SHOWING THE CRACK AND PINS AND PORTION OF WORN WHEEL

careful watch was maintained on the lashing by the engineer on watch while the assistants were busy on the wheel.

Two plates were cut out of ⅜-inch plate (the thickest plate we could find) the diameter of the wheel under the rim, with a hole large enough in the center for the boss to come through. A number of holes were drilled in the two plates and the web of the wheel, to take 1-inch bolts and ⅞-inch bolts, the smaller holes being near the crack and more numerous. We bolted these two plates on each side of the wheel, making a good, solid job.

I may mention we were helped out a lot by having on board a hand-power drill press, which in a case of this sort was invaluable as regards time and labor.

The wheel when again in its place worked well and gave no trouble at all afterwards. H. W. Hankin.

Diesel-Driven Ship for New Orleans.—Very shortly a new large motor ship will be placed in service with New Orleans as a port of call. She is for the United Steamship Company, and will trade between New Orleans and Copenhagen, Denmark. She has been named *California*, and was launched at Messrs. Burmeister & Wain's yard Aug. 23. Of the awning-deck class she is 405 feet long between the innerside of the stem and sternpost on the waterline, by 54 feet molded breadth, with 34 feet 11½ inches depth molded to the awning deck, and will have a deadweight capacity of 7,200 tons on a draft of 23 feet 3 inches. She is a twin-screw ship, and is fitted with two eight-cylinder reversible four-stroke type Burmeister & Wain Diesel oil engines, developing together a total of 2,700 indicated horsepower.

United States Battleship No. 39.—The United States battleship No. 39, which will be built at the New York navy yard, is similar in essential particulars to the U. S. S. *Pennsylvania*, now under construction by the Newport News Shipbuilding & Dry Dock Company. The length on the waterline is 600 feet; length over all, 608 feet; breadth, 97 feet ½ inch; draft, 28 feet 10 inches; displacement, 31,400 tons; speed, 21 knots; armament, twelve 14-inch guns; twenty-two 5-inch guns and four submerged torpedo tubes.

Correction.—In the description of the British battle cruiser *Tiger*, on page 290 of the July issue of this journal, it was erroneously stated that the vessel is fitted with Parsons turgines and Yarrow boilers. The *Tiger* is being built by John Brown & Company, and is being equipped with Curtis steam turbines and Babcock & Wilcox watertube boilers.

Marine Articles in the Engineering Press

The Wallsend-Howden System of Oil Burning in Marine Boilers.—Supplanting a previous article describing the succession of experiments which led up to the burner now supplied by this firm, a description is given of an installation for the use of Mexican oil, as fitted to a vessel 541 feet 6 inches long overall, 527 feet between perpendiculars, 66 feet 6 inches beam, and 41½ feet depth to the shelter deck, with a deadweight carrying capacity of nearly 16,000 tons. The engines are of the quadruple expansion type, having cylinders 28½, 51, 58 and 84 inches in diameter with a stroke of 54 inches. The boilers, designed for a working pressure of 220 pounds per square inch, are single-ended, 16 feet 3 inches outside diameter and 12 feet long each with four Deighton furnaces. Details of the oil-burning installation are described with the aid of line drawings, and trial data are given showing a fuel consumption for all purposes of 1.034 pounds per indicated horsepower by the main engines, or for the propelling engines only .907 pound per indicated horsepower per hour. 7 illustrations. 700 words.—*Engineering*, July 25.

The Port of Hamburg.—By I. F. Bubendey. This article contains information taken from an address by the Director of the Port of Hamburg, made before the American Society of Mechanical Engineers during its visit to Hamburg June 24. The fact that the Elbe River is only 800 feet wide between the harbor works on both sides necessitated the excavating of large basins, in which there are at present available in the harbor 130,000 lineal feet of quays for ocean liners, more than 5,000,000 square feet of sheds and 805 cranes for loading and unloading vessels. The chief part of the harbor itself is outside of the German customs limits, and constitutes a free port, enabling the ships to come directly to the city without being examined by the custom house officers. The volume of maritime business at this port is shown by the fact that in 1912 18,500 vessels, representing more than 14,000,000 registered tons, arrived at the port. The sheds along the quays of Hamburg are not intended for storing goods for any considerable length of time. The cargoes taken from the ships are merely assorted there, to be conveyed promptly, either by boat or by rail, to the warehouses of the city or inland. The hoisting of the goods from the ship's hold is done by revolving jib cranes, of which 650 with an average lifting capacity of 3 tons are available. The oldest are operated by steam and the more recent ones by electricity. The cranes span the railroad track along the edge of the pier, and recently double cranes, consisting of a revolving jib crane, traveling on top of the pedestal from which a lower flange conveyor is suspended, were installed. The port of Hamburg is 65 nautical miles above the mouth of the Elbe River, and sixty years ago the channel of the Elbe had a depth of only 15 feet at high tide, but by steady dredging this depth has been increased at present to 37 feet, and will be deepened to at least 40 feet in a few years. At the present time there are sixteen State-owned dredges and six chartered dredges at work on the channel. In recent years an average of 8,000,000 cubic yards have been dredged annually, 9 illustrations. 1,800 words.—*Engineering News*, July 31.

Screw Propellers.—By Capt. C. W. Dyson, U. S. N. This article is a very comprehensive discussion of the subject of screw propellers from the point of view of the designer. It takes up the methods of design, design by comparison and the effect of thrust deduction and reduction of diameter on the propulsive coefficient. The article is accompanied by eight carefully prepared charts containing a vast amount of valuable data for use in the design of screw propellers. The author's formulas for computation of screw propellers are explained. 11 illustrations. 28,000 words.—*Journal of the American Society of Naval Engineers*, May.

Photomicrographic Examination of Broken Crankshaft.—To determine, if possible, the cause of failures in crankshafts, a photomicrographic examination was made of two broken crankshafts of the C-4. The specimens were taken from the shaft near the point of rupture, and were not of sufficient size to furnish specimens for physical tests, but were ample for microscopic purposes. Physical tests made when the shaft was manufactured were available, however. Three contributory causes for the failure of the shaft were suggested by this examination: (1) Excess of impurities; (2) poor heat treatment, and (3) fatigue. The impurities created weak planes in the material, making it possible for rupture to follow across the intervening bridges of normal metal from weak plane to weak plane. The abnormally large network unbalanced the metal. As far as fatigue is concerned, it appears from recent practice that chrome-vanadium steels have a higher value than nickel steels when compared from an anti-fatigue viewpoint. It is recommended that in the case of all important members, such as crankshafts, piston rods, etc., a microscopic record be made of the finished product, and these be filed as a part of the card history of the material. 4 illustrations. 2,500 words. —*Journal of the American Society of Naval Engineers*, May.

Salt in Boiler Feed Water.—By Ensign E. E. Wilson, U. S. N. This article points out the possibility of obtaining greater economy in steam boiler performance by maintaining a low degree of salinity in the feed water. The article begins with a consideration of the source of salt in boiler feed water as well as the methods of eliminating it. Salt may enter the feed system through leaky condensers, leaky distillers, leaky evaporator coils and leaky feed-water heaters, or careless operation of the evaporating plant may admit salt. Also salt may enter through feed connections to an auxiliary feed pump, through ash ejectors, through the feed pump taking a suction from a salty boiler, through the carrying over of a highly salty boiler or through leaky bottom blow valves of dead boilers. To prevent the entrance of salt from this source, the first requisite is an efficient water testing outfit, capable of determining the grains of chlorine per gallon to at least one grain. Comparison of performances of coal consumption of steam plants, although involving many conflicting factors, has shown that if an engineer watches the chlorine content of his boilers carefully a remarkable relation is found between the degree of salinity of the boiler water and the cost of operation of the plant, even when the chlorine contents varies within such narrow limits as from zero to 20 grains per gallon. Good results will certainly accrue from a careful investigation of the possibility of the absolute elimination of salt from the boiler feed water. 2,500 words.—*Journal of the American Society of Naval Engineers*, May.

Screw Propellers.—By Alfred J. C. Robertson, A. M. I. N. A., A. M. I. E. S. The author explains in this article how to deduce simple mathematical formulæ for designing a propeller of highest efficiency to conform to any special requirements. Acknowledgment is given to the value of exhaustive trials of model propellers made by such investigators as R. E. Froude, D. W. Taylor and Professor Peabody. As Taylor's work is available in book form, the author considers in this article only the work of Froude and how his results may be made use of. The author's diagram, derived from Froude's propeller results, together with his formulæ and examples worked out to illustrate their use, is given. 1 illustration. 1,800 words.—*The Shipbuilder*, September.

The Efficient Maintenance of Turbine Machinery.—By Lieutenant Revord. This article deals with the methods adopted to insure economical working, to maintain efficiency and to reduce the chances of breakdown with turbine engines.

The main points discussed are lubrication, vacuum, utilizing of exhaust steam in turbines, loss by skin friction, eddy current loss due to errors in workmanship or to insufficient blade velocity, unavoidable leakages, cavitation, the procedure adopted when raising steam in marine turbines, working adjustment of marine turbines, the dummy clearance, gaging the wear down of bearings, repairs, reblading rotor, reblading casing, procedure adopted in opening out turbines, precautions observed and breakdowns. The article is of a practical nature, and as it is based on extended practical experience with turbine machinery it is of corresponding value. 2 illustrations. 4,000 words.—*The Shipbuilder,* September.

A New Method of Stopping a Vessel After Launching.—By A. Hiley, A. M. I. N. A., A. M. I. C. E. The speed gained by a vessel before leaving the way-ends when launched generally averages from 15 to 20 feet per second. At first the resistance of the water to the vessel's motion is considerable, but this resistance decreases very rapidly at low speeds, and the vessel would travel from three to four times her length if opposed by the water resistance alone, whereas when a vessel is launched into a restricted breadth of water it is commonly found necessary to limit the travel to from 200 to 300 feet beyond the ends of the ways. A new form of friction launching brake is described, which it is proposed to use in place of the cumbersome drag chains usually employed for this purpose. In this brake the friction length employed is composed of two steel wire ropes. Springs tightened by screws produce the requisite pressure upon the ropes, which are gripped between grooves formed in two long steel castings. These steel castings remain stationary at an anchorage while the friction ropes are pulled through the grooves by the moving ship. The brake illustrated in the article is approximately equal in effect to 80 tons of chain drags and weighs itself but 2 tons. 4 illustrations. 875 words.—*The Shipbuilder,* September.

The Quadruple-Screw Steamers Empress of Russia and Empress of Asia.—These vessels were built by the Fairfield Shipbuilding & Engineering Company, Govan, for the Canadian Pacific Railway Company's passenger service between Canada and the Far East. The vessels are 590 feet long over all, 570 feet between perpendiculars, 68 feet molded breadth, 38 feet depth molded to upper deck, 20 knots' speed and 16,810 tons gross. The characteristic features in the external appearance of these vessels are the three funnels and cruiser stern. The article describes in detail the general arrangement of the vessels, interior decorations and appliances for handling freight, as well as the heating, ventilating, lighting and sanitary arrangements. Propulsion is by Parsons turbines, arranged in series on four shafts. Steam passes first to a high-pressure turbine on the port wing shaft, then to an intermediate-pressure turbine on the starboard wing shaft, and finally to two low-pressure turbines on the inner shafts. The astern turbines are incorporated with each low-pressure turbine. All of the turbines are arranged in a single room extending the entire width of the vessel, while the condensers and auxiliary machinery are arranged in a separate watertight compartment abaft the turbine room. Steam is supplied at 190 pounds working pressure by six double-ended and four single-ended Scotch boilers, having a total heating surface of 54,250 square feet and a total grate surface of 1,344 square feet. The trials of the *Empress of Russia* were carried out at Skelmorlie, with the vessel loaded to 26 feet 8 inches mean draft. The contract maximum requirements were exceeded by three-fourths of a knot, and on a 600-mile endurance run at sea an average speed of 20½ knots was obtained, or half a knot in excess of the contract requirement, with the coal consumption about 10 percent less than that guaranteed. 9 illustrations. 1,900 words.—*The Shipbuilder,* September.

The Injury to the Hull of the U. S. S. Arkansas by Grounding.—While the battleship *Arkansas* was proceeding at a speed of 12 knots from Guaycanaybo Bay, Cuba, to Guantanamo, at 6 o'clock in the evening of Feb. 11, 1913, the vessel struck bottom when drawing slightly over 25 feet forward and 28 feet aft. The obstructions undoubtedly consisted of uncharted coral pinnacles, which were apparently broken off by the ship riding over them, as the damages to the hull decreased toward the stern. A succession of shocks was felt on board the ship, and the vessel rolled first to one side and then to the other. The crew responded promptly to the call for collision quarters, and after all watertight doors and hatches were closed it was found that some twelve of the double-bottom compartments were leaking, although the water in several of these could be kept down by the pumps. The inner bottom held, and the leakage was confined practically to those compartments that were opened to the sea by the damage to shell plating and which were of comparatively small volume. The vessel came North to the Brooklyn navy yard without convoy and was floated into drydock No. 4. Examination of the bottom of the vessel showed that one pinnacle rock struck the bottom just under the port forward bilge keel, and distorting this badly forced in the shell plating in way of it. Another rock scraped along the bottom of the port side for over 200 feet, and for that distance made an indentation similar to an inverted trough, opening seams, tearing holes in the shell plating and buckling framing, brackets and longitudinals. On the starboard side a rock struck and caused similar damages for a distance of over 100 feet. That the damage sustained by the vessel as a whole was so comparatively small is attributed by the author to the excellent material and workmanship in the ship and the rigidity of the structure as designed. The repairs required involved the removal of twenty-eight shell plates, of which twelve were so badly damaged as to require replacement with new ones. Internal framing and brackets were badly buckled and broken, and had to be repaired by cutting out and renewing. While repairs were being made, special precautions were made to strengthen parts of the ship which showed signs of distortion on account of the removal of damaged portions. The behavior of the *Arkansas* under these damaged conditions is compared with that of the *Titanic,* and the inference is drawn that if the *Titanic* had been supplied with a double bottom extending completely over the underwater part of the hull the ship could have been saved. The efficiency of an inner skin having been thoroughly established, as far as the bottom of the ship is concerned, there is no reason to suppose that it would not be equally efficient as a protection for the sides of a ship. 5 illustrations. 1,500 words.—*Engineering News,* September 4.

The New Spanish Battleships.—The three new Spanish battleships—*España, Alfonso XIII* and *Jaime I*—all of which were built at the reconstructed Ferrol Arsenal by the Sociedad Española de Construccion Naval, are of the following dimensions: Length over all, 465 feet; length between perpendiculars, 435 feet; beam, 78 feet 9 inches; draft, 25 feet 6 inches; displacement, 15,450 tons; shaft horsepower, 15,500; speed, 19½ knots; radius of action at 10 knots' speed, 7,500 miles; armament, eight 12-inch 50-caliber guns; twenty 4-inch guns; six smaller guns. The main armor belt, extending for three-quarters of the length of the ship, is 9 inches thick, the strake above this is 6 inches thick, and the upper strake, 3 inches thick. The barbettes and gun hoods are protected by 10-inch armor, and the vital parts of the ship under the waterline are exceptionally well protected by longitudinal bulkheads 1½ inches thick. Propulsion is by Parsons compound turbines, driving four propellers at about 365 revolutions per minute. The propellers are of bronze, three-bladed, 7 feet 10½ inches diameter and 7 feet pitch. Steam is supplied at 235 pounds pressure by Yarrow large tube boilers, with a combined heating surface of 46,000 square feet and a grate area of 882 square feet. 10 illustrations. 3,000 words.—*Engineering,* August 8.

New Books for the Marine Engineer's Library

Beeson's Marine Directory of the Northwestern Lakes. By Harvey C. Beeson. Size, 6¾ by 9¾ inches. Pages, 272. Numerous illustrations. Chicago, 1913: Harvey C. Beeson. Price, $5.00.

The main features of this book, which is now in its twenty-seventh year of publication, are the lists of American and Canadian steam and gas-engined vessels on the Great Lakes, the lake vessels whose names have been changed, the records of the engines and boilers and a section devoted to all the marine associations, both American and Canadian, on the Great Lakes. Interspersed among the tables are numerous items and articles, supplemented with illustrations relative to lake navigation and its growth, and marine affairs of importance the world over.

Worm Gearing. By Hugh Kerr Thomas. Size, 6 by 9 inches. Pages, 86. Illustrations, 33. New York, 1913: McGraw-Hill Book Company. Price, $1.50 net.

With the somewhat recent development of worm gearing in connection with the reduction gear of steam turbines for ship propulsion, the subject of worm gearing has become of increasing importance. This book will, therefore, be found of particular value to those who are concerned with this application of worm gearing, for it is practically the only book available in which a complete analysis of the principles of the design of worm gearing has been made. While a limited number of engineers may be familiar with the contents of the book, the data which it contains have not hitherto been accessible to the designer and draftsman in complete form.

The "Newest" Navigation Altitude and Azimuth Tables. Second Edition. By Lieut. Radler de Aquino (Brazilian navy). Size, 6 by 9½ inches. Pages, 268. London, 1912: J. D. Potter, 145 Minories, E. C. Price, 10/6 net.

The tables in this book were compiled by the author to form a simple and ready means for facilitating the determination of lines of position and geographical position at sea. The advance of this work over the existing tables for the same purpose consists in abridging the extent of the existing tables by tabulating the solutions of the two right-angle spherical triangles into which the astronomical triangle may always be divided. All sights for position are worked out by the same method without logarithms and with hardly any calculation. All other problems in navigation are easily and rapidly solved by inspection without interpolation.

Data Book for Shipbuilders and Naval Architects. By Pio Agapito. Size, 5⅝ by 8⅝ inches. Pages, 110. Trieste, Austria, 1913: Liberia Ettore Vram. Price, 2/6 in Austria; 2/10 abroad.

The author of this book, who is a naval architect, found in the course of his experience, as nearly every naval architect does, the importance of having a systematic form of tabulating data covering the design of various types of ships. To accomplish this end he has arranged in a remarkably clear and systematic form data sheets which have been printed and bound in book form, on which can be entered the principal dimensions, scantlings, capacities, etc., of vessels as well as trial data showing the performance of the vessels. At the end of the book a number of pages are printed with blank forms on which can be recorded the body plan offsets of vessels for guidance in future designs when drawings of a vessel are not available. This data book should prove of great value to naval architects who have not yet worked out a convenient form for recording construction data. A complete index should, of course, be added to such a book for reference purposes.

Steam Turbines: Their Theory and Construction. By H. Wilda. Size, 4⅝ by 7¼ inches. Pages, 191. Illustrations, 104. London, 1912: Scott, Greenwood & Son, and New York, 1912: D. Van Nostrand Company. Price, 3/6 net; $1.25 net.

In view of the many lengthy and exhaustive treatises on steam turbines, the appearance of such a small book as the one under review, which has for its subject theory and construction of steam turbines, is rather astonishing. The book is one of a series of engineering handbooks; but it can be classed as a handbook only in point of size, as the data which it contains and the treatment of the subject are exceedingly brief, while neither the illustrations nor the explanatory text give sufficient information about the details of turbine construction to be of practical value to an engineer. The part of the book which deals with the theory of steam turbines is especially limited in character, and can by no means be considered an adequate treatment of the subject.

Fighting Ships. Sixteenth Edition. Edited by Fred T. Jane. Size, 12½ by 7½ inches. Pages, 518. London, E. C., 1913: Sampson, Low, Marston & Company, Ltd. Price, 21/– net.

The 1913 edition of "Fighting Ships" is arranged in the same manner as in previous years, containing the main particulars of practically all the naval vessels in the world, arranged according to nationality in the order of strength. The leading sea powers appear in the same order as last year, Great Britain being first, Germany second, the United States third, Japan fourth, France fifth, Italy sixth, Austria seventh and Russia eighth. The Editor assures the readers that the greater part of the book is now placed upon an official revision basis and that the information given, while occasionally curtailed on account of the secrecy maintained by various Admiralties, is in the main free from errors which have appeared in previous issues, especially as regards the dimensions of docks and the details of private yards. The book is replete with excellent illustrations of various naval vessels, many of which are new. The second part of the book contains an interesting article by Charles de Grave Sells, M. Inst. C. E., on the "Progress of Marine Engineering." The subjects discussed in this article include turbines, reduction gearing, torsion meters, boilers, forced draft apparatus, valves, oil engines, hydro-aviation, submarine attack and submarine salvage.

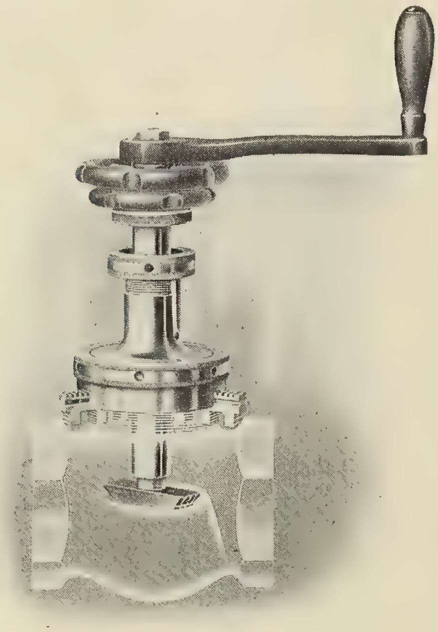
Engineering as a Profession. By A. P. M. Fleming, M. I. E. E., and R. W. Bailey, Wh. Sc. Size, 4¾ by 7½ inches. Pages, 288. London, 1913: John Long, Ltd. Price, 2/6 net.

Failure to win success in the engineering profession is many times due to a lack of knowledge as to what constitutes a suitable course of training and ignorance of the conditions governing engineering employment. A good engineer needs a good training and a knowledge of the limitations and possibilities of the field of work in which he enters. The question of co-relating the technical and practical portions of an engineer's training so as to secure the best results has been discussed at considerable length, but very little has previously been written regarding the facilities that actually exist for obtaining the most satisfactory training and employment. It is to supply this deficiency that this book has been written. It aims first at giving a broad, general outline of the field of engineering activity for the benefit of those who have only a popular conception of engineering matters, and a comparison is drawn between engineering and other well-recognized professions. The final chapters of the book take up the subjects of engineering appointments and foreign methods of training engineers.

ENGINEERING SPECIALTIES

The Improved Dexter Valve Reseating Machine

The improved Dexter valve reseating machine (Williams' patent), manufactured by the Leavitt Machine Company, Orange, Mass., is the result of many years' experience on the part of the manufacturers in specializing on tools for repairing valves. The model of the machine shown in the illustration is made in two sizes for reseating all flat and taper-seated valves, from ¼ to 3 inches and from ¼ to 4 inches. These machines, it is claimed, are positive in operation, as they true up a worn valve seat and its disk exactly alike, making a perfectly tight seat for water or steam. The illustration shows the machine attached to a globe valve with a taper cutter at work on the valve seat. An improvement in the jaws provides for securely attaching the machine to valves that have threads



on the outside of the body as well as for attaching to valves that are threaded on the inside and also for flanged cap valves.

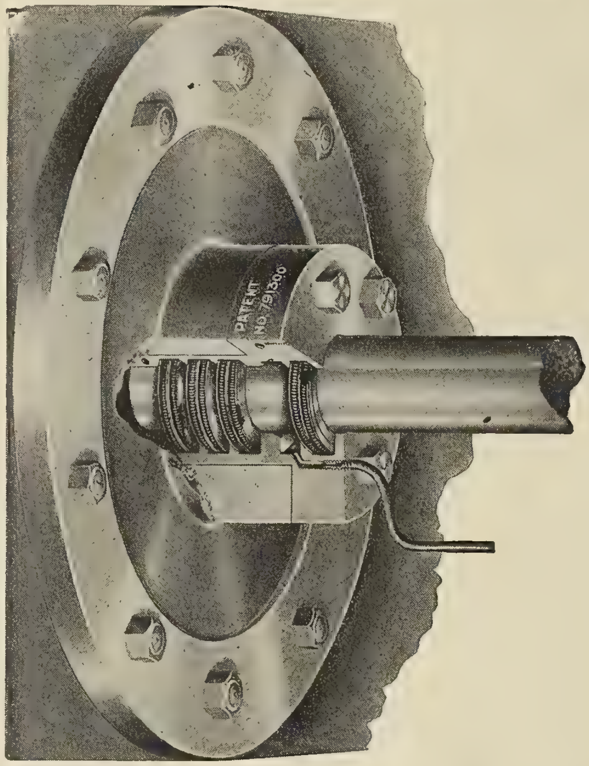
The operation of the machine is a simple matter. Its jaws are quickly adjusted to the valve casing by merely rotating the scroll of the chuck. This centers the machine and the tool spindle is placed in perfect alinement. A few turns of the handle and the seat is accurately recut, the entire job occupying only a few minutes. After the operation is finished, it is claimed, the valve is as good as new, and the same valve can be reseated from ten to twenty times, thus saving the cost of a new valve each time, and giving an opportunity to reclaim valves which have been consigned to the junk heap.

Some features of construction of this machine are distinct improvements. The bearing sleeve, which holds the tool spindle, extends through the chuck and is threaded on the inside of its upper end. These threads engage with the threads of the feed screw on the tool spindle. The bearing sleeve with the tool spindle slides through the chuck, and is instantly lowered to or raised from the valve seat, and is held in position by rotating the large nut shown on the body of the machine. The bearing sleeve supports the tool spindle practically its entire length, which not only strengthens the tool shaft but keeps it in perfect alinement regardless of the strain upon it, thus adding greatly to the life and usefulness of the machine.

The work of reseating the valve with the Dexter machine can be done by an ordinary mechanic without disconnecting the valve from the pipe line. Breaking connections and removing a valve because it leaks and putting in a new one is unnecessary and expensive, and frequently a source of trouble, for new valves may be leaky themselves. The value of this machine, therefore, for repairing leaky valves is apparent.

The Holmes Metallic Packing

The Holmes Metallic Packing Company, Wilkes-Barre, Pa., manufactures a metallic packing which is made of the same material as the piston rings and the cylinder of the engines in which the packing is installed. As can be seen from the illustration, the packing is contained in a metal case made in halves, which is made to fit the stuffing-box for which it is designed. The case is securely screwed together and then pushed to the bottom of the stuffing-box. A joint is made of lead tubing at the bottom of the stuffing-box. The packing can be placed in the stuffing-box without disconnecting the



rod, and the operation can be performed in a very short time. Also, the packing can just as readily be removed from the box and taken apart when necessary.

The Holmes metallic packing is suitable for use on piston rods, valve stems, rotary valve stems, stop cocks, air pumps, compressors, or gas engines, as it is both steam and air-tight. It is claimed that the packing will not cut or score the rod, and when the engine is inactive it will not blister or rust the rod or stem. In other words, if the rod is in good condition when the packing is applied it will remain so and will not have to be turned when the engine is repaired.

A special feature of the Holmes packing, designed especially for marine work or for any engine where there is an excess of condensation, is the patent water-pocket packing, the construction of which is shown in the illustration.

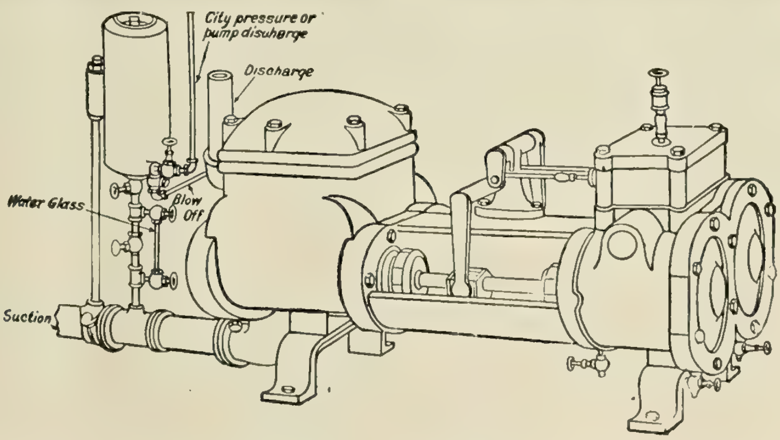
Ruins Removed by Oxy-Acetylene Apparatus

Early in January of this year the Carnegie Steel Company's plant in Baltimore, Md., was completely destroyed by fire, leaving a huge mass of buckled iron and steel twisted into every imaginable shape. Apparently it would require several months before this tangled mass of iron and steel could be cleared away, but by installing an oxy-acetylene welding and cutting plant the twisted mass of iron and steel was cut into short, movable lengths, so that it could be hauled away in a remarkably short time. The plant installed for this work, supplied by the Alexander Milburn Company, Baltimore, Md., was mounted on a truck and moved from place to place as the work required. Fifty-foot lengths of hose were used, which gave a

fairly long range of work. The work progressed without trouble or mishap, and one operator and helper, with a single torch, were able to cut up the iron into movable lengths faster than a force of five men could load it on rail trucks and take it away.

A Boiler Graphite Feeder

The illustration shows a graphite feeder furnished by the United States Graphite Company, of Saginaw, Mich., which is designed to accomplish a steady, gradual feed. This feeder has a reservoir which is so equipped with valves that it may be entirely closed and all water pressure shut off. The water valve is then opened so that the ordinary city water pressure is applied to the reservoir of the feeder and then this combination of water and graphite is fed through an outlet valve at the bottom of the reservoir into the feed water onto the suction side of the pump. This valve, permitting the water saturated with graphite to pass through, can be readily adjusted by watching the water glass to see how fast it is traveling. With a little experience the engineer soon becomes able to regulate this valve so that there will be, through the hours of operation, a constant leeching of graphite going into



the boiler with the feed until the contents of the reservoir become exhausted, when the valves are again closed, and by means of a drain valve which is on the reservoir it is emptied of the clear water remaining in it and then again filled with graphite and regulated as before. After a little experience and measuring of time the valve through which the graphite passes into the feed water can be set and marked so that the engineer will know just where to open it each time in order to give his dose as specified. The illustration shows the manner in which the feeder is connected with the feed line at the suction side of the pump.

The Donald Patent Elevator-Conveyor

Labor-saving appliances for loading or discharging ships are generally recognized as being more efficient when they can be operated continuously rather than intermittently. Only intermittent working is possible, however, with the usual ar-

rangements of cranes and derricks, which are commonly used at steamship terminals, and to improve such service the Donald elevator-conveyor has been placed on the market by Rownson, Drew & Clydesdale, Ltd., Upper Thames street, London, E. C. This conveyor is designed to save both labor and time in handling certain classes of miscellaneous cargo both for loading and unloading ships. It is so constructed as to work independently of the rise and fall of ships, due to the alteration in the water level or to cargo working. It can be raised or lowered to follow the cargo as the vessel is emptied or filled. The drive is preferably by a motor, of from 1 to 5 horsepower.

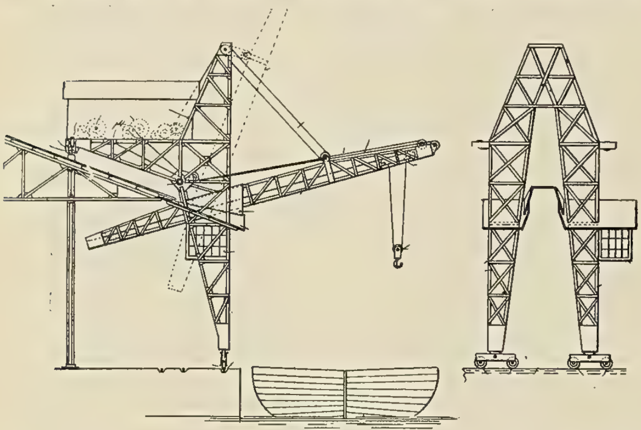
SELECTED MARINE PATENTS

The publication in this column of a patent specification does not necessarily imply editorial commendation.

American patents compiled by Delbert H. Decker, Esq., registered patent attorney, Loan & Trust Building, Washington, D. C.

1,064,384. CARGO-HANDLING APPARATUS. HARRY SAWYER, OF MUSKEGON, MICHIGAN.

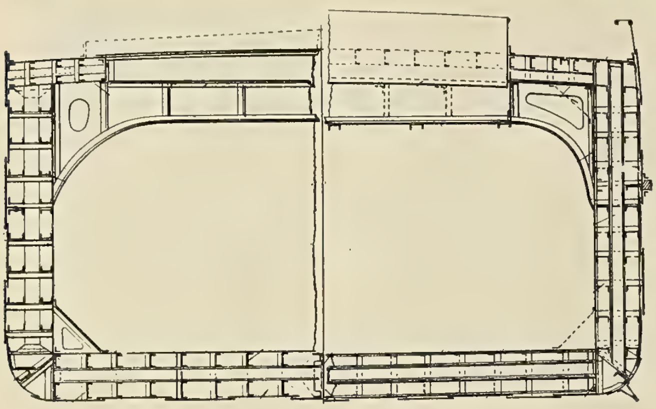
Claim 2.—A floor, an elevated structure erected thereon, a roof carried by said elevated structure, track rails respectively carried by the



floor and above the roof, a crane structure having portions respectively resting upon and operating along said track rails, and a roof section carried by said crane structure. Five claims.

1,066,039. SHIP CONSTRUCTION. JOSEPH R. OLDHAM, OF CLEVELAND, OHIO.

Claim 1.—A steel ship or vessel, having inner and outer skins and comprising a plurality of longitudinal inner and outer spaced channel bar frames, transverse frames each comprising central channel bars extending across the bottom and sides between the inner and outer lon-



gitudinal frames, cross bars secured to the longitudinal and transverse frames and intercostal transverse bars filling the spaces between the central transverse frame bars and the inner and outer skins and secured thereto and to the transverse bars with angle bars and bracket plates. Eleven claims.

1,066,636. BUOY. THOMAS J. MACGENN, OF PORTLAND, OREGON.

Claim 2.—In a gas buoy having a gas chamber, supporting frame, gas burner and communicating pipes between said chamber and burner, the combination therewith of means pivotally supporting said burner, and a rudder resting in a vertical plane at right angles to the axis of said pivotal support for said burner, whereby to determine the position of said buoy relative to the movement of the water and to insure a plumb position for said burner. Four claims.

1,066,988. PROPELLER. WILLIAM R. BOUTWELL, OF NORFOLK, VIRGINIA.

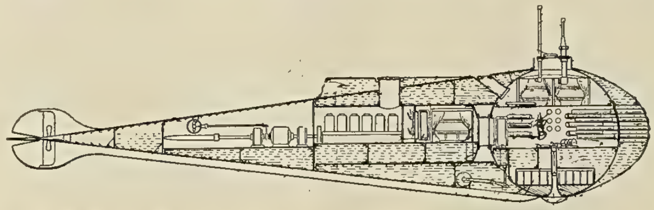
Claim 1.—In a propeller, the combination of a propeller blade having a number of perforations near its forward edge adapted to admit therethrough a small portion of the fluid propelled, said perforations being disposed at an angle directing the fluid against the back wash whereby to direct the latter between two adjacent propeller blades, and a diverting blade mounted upon the front face of said propeller blade and having one end located nearer the center of rotation than the opposite end thereof whereby to divert outwardly the flow of back wash against the front face of the propeller blade. Three claims.

1,067,207. SOUND-SCREEN. ROBERT L. WILLIAMS, OF NEWTON, MASACHUSETTS, ASSIGNOR TO SUBMARINE SIGNAL COMPANY, OF WATERVILLE, MAINE, A CORPORATION OF MAINE.

Claim 4.—The combination with a water containing tank, of a sound screen within said tank comprising a water tight casing having two or more solid walls or partitions inclosing between them one or more gas containing chambers. Five claims.

1,067,371. SUBMARINE OR SUBMERSIBLE TORPEDO-BOAT. EDWARD LASIUS PEACOCK, OF BRIDGEPORT, CONNECTICUT, ASSIGNOR TO THE LAKE TORPEDO BOAT COMPANY, OF BRIDGEPORT, CONNECTICUT, A CORPORATION OF NEW JERSEY.

Claim 1.—A submarine or submersible torpedo boat, having bow, amidships and stern sections, and an interposed substantially globular



hull section containing an interior compartment provided with torpedo expulsion tubes whose inboard or loading ends open within said compartment. Thirty-one claims.

1,068,276. BOAT-CHOCK. WILLIAM S. ROGERS, OF NEWPORT, RHODE ISLAND.

Claim 1.—In a boat chock, the combination of a main stationary member, a movable member supported normally thereupon, and means to control the movement and position of the movable member with respect to the stationary member, said means comprising a rock shaft journaled

upon both of said members and slidable along one of them, said rock shaft having at one end a crank interlocking with the end of the member along which the rock shaft is slidable. Two claims.

1,067,601. BELL-BUOY. JOHN GILLIS, OF THE UNITED STATES NAVY.

Claim 1.—A bell buoy provided with an anchored float, a framework on the float, a bell mounted on the framework, a revoluble shaft carrying a pulley and mounted on the said framework, a chain passing over the pulley and fixed at one end, a weight at the other end of the chain, an air compressor driven from the said shaft and discharging into the float, and a pneumatic hammer for sounding the bell and driven by the compressed air in the float. Nine claims.

British patents compiled by G. F. Redfern & Company, chartered patent agents and engineers, 15 South street, Finsbury, E. C., and 10 Gray's Inn Place, W. C., London.

23,121. IMPROVEMENTS CONNECTED WITH SHIPS' STEERING GEAR. J. R. CLAY, OF BOOTLE, LANCASHIRE.

Claim.—In the steering gear of a ship in which the hand-operated part has a locking or preventive means connected with the hand-wheel pillar or stand, and is adapted to be operated by the navigator or commander, and comprises pawls and ratchet wheels; the invention consists in arranging such pawls so that they can be rocked on their pivots by the ratchet wheel which they work in connection with, when being revolved in and the required direction, without the movement of the lever, which moves them, or causes them to move into and out of action with their respective ratchet wheels and is actuated by the navigator or commander.

29,938. IMPROVEMENTS IN REINFORCED CONCRETE BARGES, LIGHTERS, ETC. N. K. FOUGNER, OF HONG KONG, CHINA.

Claim.—A vessel of the lighter barge type suitable for sea-work and built entirely of reinforced concrete, comprises a number of transverse frames of a suitable section and some of them continuous or ring-like formed or connected with several longitudinal parallel beams in the bottom, sides and deck, these beams at their ends converging towards the stem and stern posts of the vessel, stiffener beams diverging upward from the keel beams to the sides of the vessel, the stem and stern posts being vertical or slightly inclined outward, and watertight bulkheads at the transverse frames nearest the stem and stern. The ends of the vessel beyond the bulkheads may be formed with a solid reinforced deck having one small hatchway closed by a watertight hatch provided with means for battening it down to resist water pressure, thus forming a watertight compartment at each end of the vessel beyond the bulk heads.

13,742. IMPROVEMENTS IN THE CONSTRUCTION OF FLOATING VESSELS. J. W. ISHERWOOD OF LONDON, E. C.

Claim.—Improvements in the construction of floating vessels particularly applicable to, and advantageous in the "Isherwood" system, consist in attaching deck longitudinals above the deck plates and in locating the walls of cabins in line with the deep, strong, widely-spaced transverse Isherwood frames and beams, and the longitudinal deck beams, respectively.

International Marine Engineering

Published Monthly by ALDRICH PUBLISHING CO.

17 BATTERY PLACE, NEW YORK | 31 CHRISTOPHER ST., LONDON, E. C.

H. L. Aldrich, President and Treasurer
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Edited by H. H. Brown, A. M. Inst. N. A.
Member Soc. N. A. and M. E.

Vol. XVIII | NOVEMBER, 1913 | No. 11

Western River Steamers, Engines and Boilers

BY E. A. BURNSIDE

The flat-bottom stern-wheel steamers used on the Western and Southern rivers of the United States are sometimes held up to scorn by seafaring men in the Eastern States and in foreign countries, on account of both the unusual style of naval architecture and the apparent lack of progress made by the builders in the design of hulls and machinery.

FIG. 1.—TYPICAL STEEL HULL OHIO RIVER TOWBOAT. TOWING CAPACITY—WITH CURRENT—32 BARGES OF 550 TONS EACH

It is true that changes and progress have been slow in the construction of steamboats on the Western rivers, and they will be slow for years to come; for the reason that the early designers and builders of river steamers built exceedingly well, considering the materials at their disposal. They built to meet the special needs of the traffic then offered, and it required no little ingenuity to meet the restrictions imposed by the changes in the navigable stages of water in the rivers. In the early days the condition of the rivers for navigation was general dangerous, and this holds true even in late years, as will be realized by an inspection of some of the photographs accompanying this article. With such conditions to meet, the necessity for cheaply-constructed boats was a very important consideration, and it must be admitted that these conditions were met and complied within a remarkably successful manner, resulting in the development of a type of stern-wheel steamer which has stood the test of many years' service without any need for radical improvements.

Towboats

Western river steamboats are used as packet boats, freighters and for towing purposes. Most of the steamboat tonnage now afloat on the Western rivers is in the form of towboats, and by far the largest part of the freight moved on the rivers is handled by towboats. The majority of the towboats are stern-wheel steamers of the same general form as were built forty years ago. These boats are also engined and boilered with the same general type of machinery as was used at that time, and it should be noted that the engines and boilers of this type are doing good work and showing a combined boiler and engine efficiency that would surprise many marine engine builders, who would otherwise be disposed to ridicule the so-called obsolete types of machinery which are still used to a great extent on the Western rivers.

Improvements in Hull Construction

The only particular change in hull construction of wooden towboats has been the change from "skag" sterns to the scow or round form of stern, which is sometimes called a "goose" stern. The "skag" stern was a formation of the hull at the stern of the boat, with deadwood timbers connecting the rudder posts to which the two wing rudders were fastened. The "skag" type permitted the use of but one or two balanced rudders and two wing rudders, the wing rudders being fastened at the foot of the rudder post with no extension of blade forward of the rudder stock. On the other hand, the round form of stern, or "goose stern," permits the use of three or more balanced rudders.

This change was brought about for the reason that the use of all balanced rudders gave the steamer better handling efficiency in backing or flanking. This was a much desired result in towboats handling large tows, but the fact remains that the old-style "skag" stern towboats, while not handling so well usually as the scow or round-stern boats, nevertheless steered ahead much better and prevented the steamers from "sliding" as much as did the other type of boats.

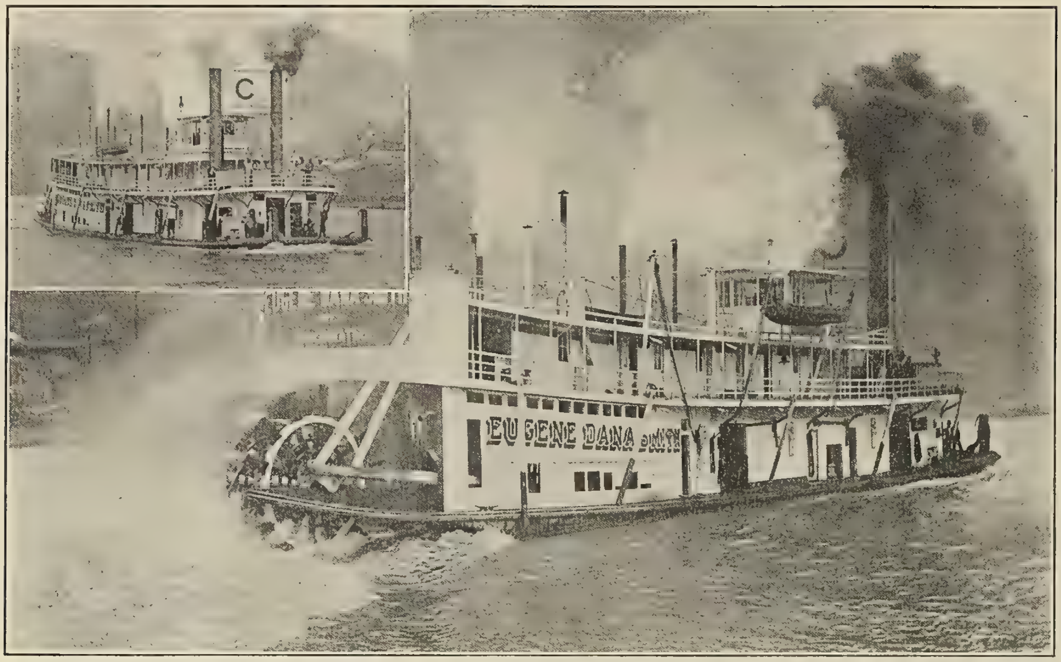


FIG. 2.—VIEWS OF STERN WHEEL TOWBOAT EUGENE DANA SMITH

FIG. 3.—TWIN SCREW TUG IRON DUKE HANDLING BARGES AT A COAL TIPPLE

Tunnel Boats vs. Stern-Wheelers

Attempts have been made to use the tunnel type of screw-propelled shallow draft boats on the Western rivers, and it is claimed by the builders of this type that they will out-flank and out-handle the stern-wheel towboat, but, so far as the writer's observation goes, and from what he has been told, the tunnel type boat will not handle loaded tows down stream, where there is much flanking or difficult handling, as well as the stern-wheel towboats. The average Western river boatmen, owners and pilots alike, have not yet become convinced that the tunnel boats will equal their old-style stern-wheel towboat for such purposes. It is true that tunnel boats, built for special work, have made some remarkable records in the saving of fuel in freight towing on the Mississippi and in Government river improvements, showing maximum power and speed with a minimum draft of water, but, nevertheless, in some respects, and in certain classes of work, it is the writer's opinion that they cannot equal the better class of stern-wheel towboats and will never surpass them.

Remarkable Records of Old-Style Boilers

The old-style Western river steamboat boiler, which is still almost universally used on these boats, has been condemned and maligned and proved by "theorethical calculations" to be very inefficient and wasteful in fuel consumption. It is a matter of fact, however, that a number of watertube and other modern types of marine boilers which have been installed on Western river steamers have in a short time been removed, and the old-time horizontal two, five and six-flue boilers, as the case might be, put back on the steamers. A case in point is that of a towboat owner who has had in use for a year what was claimed to be the most efficient and safest boiler for towboat use, but who is about to remove this boiler and install in its place the old-time horizontal two-flue Western river boiler.

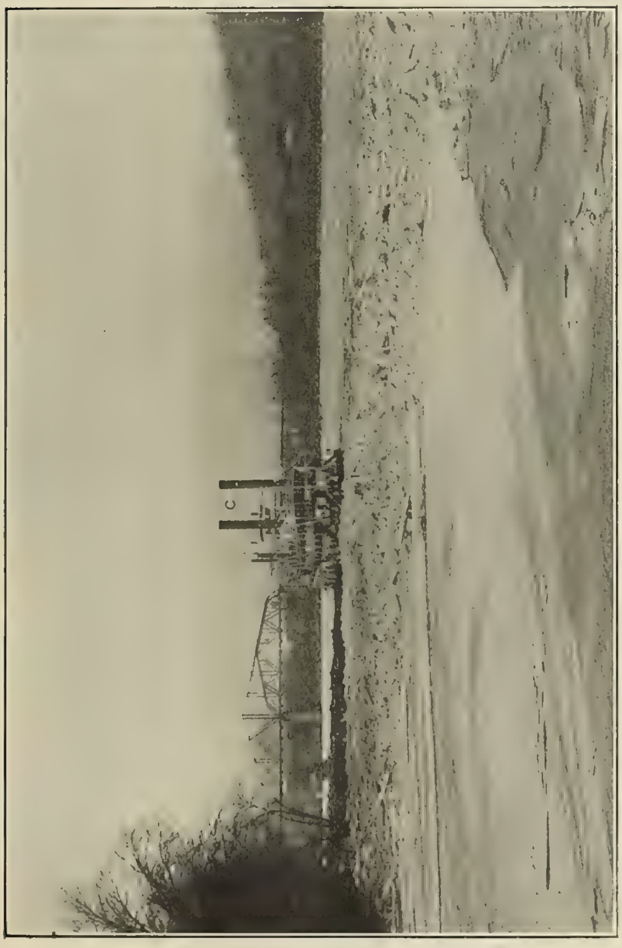


FIG. 4.—ICE OBSTRUCTION AHEAD OF TOW OF COAL BARGES

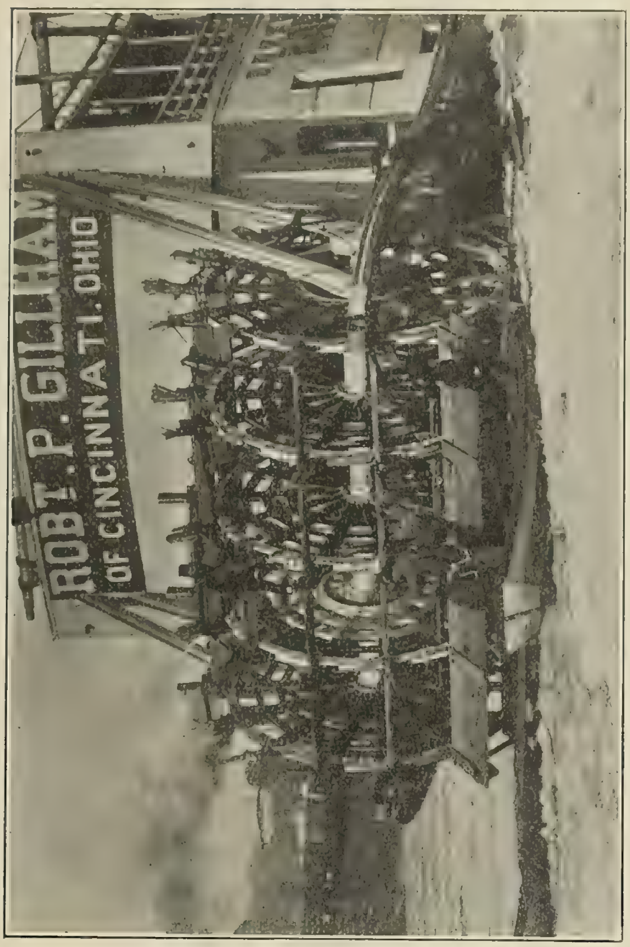


FIG. 5.—REPAIRING WHEEL BROKEN IN ICE GORGE

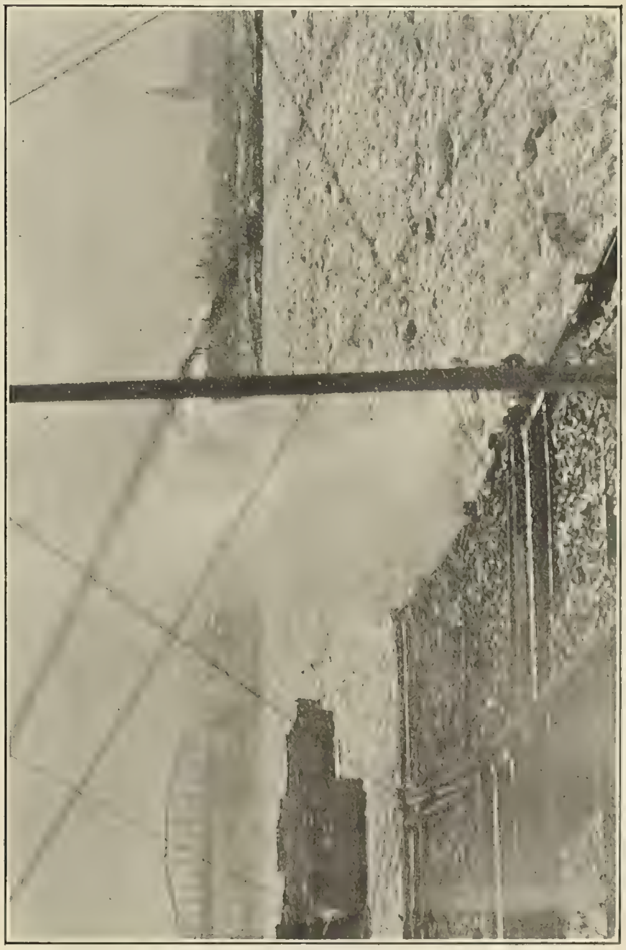


FIG. 6.—BLASTING AWAY AN ICE OBSTRUCTION

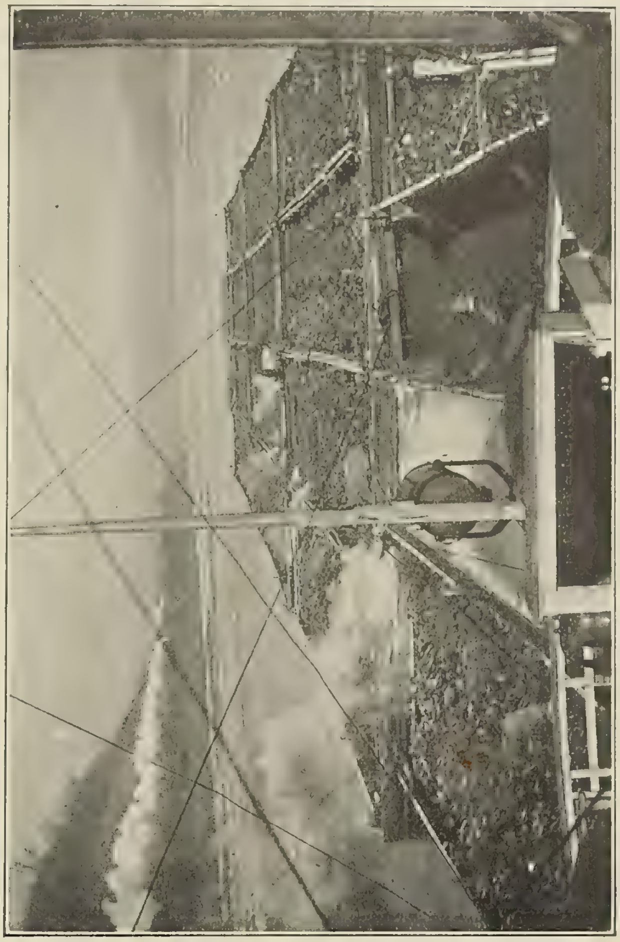


FIG. 7.—TOW OF COAL BARGES AS USUALLY ARRANGED AHEAD OF THE TOWBOAT

The company with which the writer is associated now has in use one boiler over twenty-two years old of the old horizontal type with two flues, which at times has been forced to its utmost capacity twenty-four hours every day, for as much as sixty days at a stretch, and which in all of the twenty-two years it has been in service has not been out of use over six months' time; yet the cost of repairs on the boiler for this almost continuous service for twenty-two years has not been over $35 (7/5/10). Another battery of six horizontal two-flued boilers on one of the towboats belonging to the same company has been in use for fifteen years and has cost but $6 (1/5/0) for repairs.

The horizontal river type boilers are externally fired, and fire cracking of the laps in the shell plates outside of the rivet holes in the seams over the fires is about the only trouble that is experienced with this type of boiler. Occasionally a boiler is burned by an accumulation of scale, but this fault is often remedied by changing the disposition of the feed water inside the boiler.

Considering the fact that this type of boiler has been in use for three generations; that it meets the requirements of the special class of traffic and type of boats used on the Western rivers; that it is efficient; that it is capable of producing far greater horsepower than its theoretical rating; that it is not excessive in fuel consumption, considering the grade and kind of coal used; that it is reasonable in first cost, and that it is easily accessible for repairs, it seems safe to conclude that it will be many years before any boiler is built that will supplant the old-time two-flued cylindrical boiler for use on the Western river stern-wheel steamers.

The Engines

As is well known, the type of engines used on the stern-wheel steamers is the long-stroke, high-pressure, non-condensing engine equipped with some one of the several various types of valve gear. Many recent boats of this class are now being equipped with a type of engine known as the tandem compound condensing engine. These engines effect quite a saving in fuel as well as giving surplus power when wanted. Three or four of the foremost engine builders along the Western rivers are now building this type of engine almost exclusively.

No detailed description of these engines is necessary, as they have been described and designs have been illustrated in this publication in previous issues.

Towboat Eugene Dana Smith

A good example of the small towboats recently built on the Western rivers is shown in Fig. 2. This boat is the *Eugene Dana Smith,* of 99 tons, equipped with three cylindrical two-flue boilers and two high-pressure non-condensing engines. The boilers are 40 inches diameter and 24 feet long, arranged in a single battery connected with steam and mud drums, each boiler having two 14-inch flues and allowed a working steam pressure of 198 pounds per square inch. The engines have cylinders 14 inches diameter and 72 inches stroke, with California cut-off valve gear and "inside" cam gear. This cam gear operates the valve gear without the use of cams on the stern-wheel shaft, the gear being attached to the "pitman," or engine driving rod. The stern-wheel is 15 feet 9 inches diameter, fitted with fourteen buckets, each 17 feet long and 30 inches wide. The average number of revolutions of the wheel is about 22 with a loaded tow and about 24 with an empty tow.

The fuel consumption of the three boilers per twenty-four hours in up-stream work is about 600 bushels of 1-inch slack coal, which is equivalent to about 24 tons. With a full supply of coal, or enough for about a fifty-two hours' run, and with a complete outfit on board the steamer, the vessel draws about 48 inches of water. When the vessel is light with fuel for a six hours' run, but with most of the outfit still on board, the boat draws 36 inches of water.

The towing capacity of the boat, as it is commonly termed, is fourteen barges. These barges are of about 550 tons burden loaded. The up-stream capacity of the boat is about twelve empty barges and fuel flats, which is equivalent to about 1,400 tons. This capacity is rated against a river current of 4 miles per hour when the boat is making a speed of about 3 miles per hour.

FIG. 8.—SMALL RIVER PACKET BOAT, A TYPE GENERALLY USED ON THE OHIO AND MISSISSIPPI RIVERS

FIG. 9.—COAL HARBOR AT MOUTH OF KANAWHA RIVER, WEST VIRGINIA, WITH FLEET OF TOWBOATS PREPARING TO MOVE LOADED TOWS

The *Eugene Dana Smith* is 123 feet long as measured on the hull and 143 feet long over all, including the wheel. The beam is 27 feet and the depth 4 feet. She was built for special service in towing coal, and was especially strengthened for ice-breaking during the winter season. The hull is constructed of the best Kanawha white oak, all timber in the hull, except the decking, being saturated in salt brine for about two years. The timbers are fastened with galvanized spikes and bolts. The steamer is provided with electric lights and a searchlight, steam steering gear, etc., and responds very quickly to her helm.

THE IRON DUKE

Another vessel of interest, built for a special service, and known as a "tug pump boat," is the *Iron Duke,* a vessel 82 feet long, 14 feet wide and 4½ feet deep. The hull is built of Kanawha oak and is propelled by twin screws. The propellers are four-bladed, 58 inches diameter and 82 inches pitch. Owing to the shallowness of the hull and the draft, which is only 42 inches, the wheels are set so that the blades extend 9 inches below the bottom of the boat and 7 inches above the water.

The machinery consists of two sets of vertical fore-and-aft high-pressure engines, the cylinders of each engine being 9 by 12 inches. Complete with the thrust block each engine weighs 3,000 pounds. At normal speed the engines turn at about 240 revolutions per minute. Steam is supplied at 180 pounds pressure from a cylindrical two-flued boiler, 44 inches diameter and 22 feet long, with flues 16 inches diameter.

Both the boiler and engines are placed aft of the center of the boat owing to the installment of the pumping apparatus, which has a swinging boom supporting a suction pipe leading from a large duplex pump. The boom carries the suction pipe some 30 feet beyond the side of the steamer, and the boat was built for the special work of pumping and moving loaded and empty barges. She is capable of a speed of 10 miles an hour, and with her twin screws is a handy towboat, easily handling two barges of 550 tons capacity each. Fig. 3 shows the *Iron Duke* in use as a towboat, exchanging an empty barge for a loaded one at a coal tipple.

SEA-GOING MOTOR TORPEDO BOAT.—Messrs. Yarrow & Company, Ltd., Scotstoun, Glasgow, built recently a 100-foot sea-going torpedo boat, or gunboat, propelled by internal combustion engines. The beam of the boat is 13 feet 6 inches, and in light trim she is capable of a speed of 23 knots. At cruising speed a radius of action of no less than 600 miles can be obtained. The boat can be armored with three 3-pounder guns or two 6-pounder guns or one torpedo tube, as occasion may require.

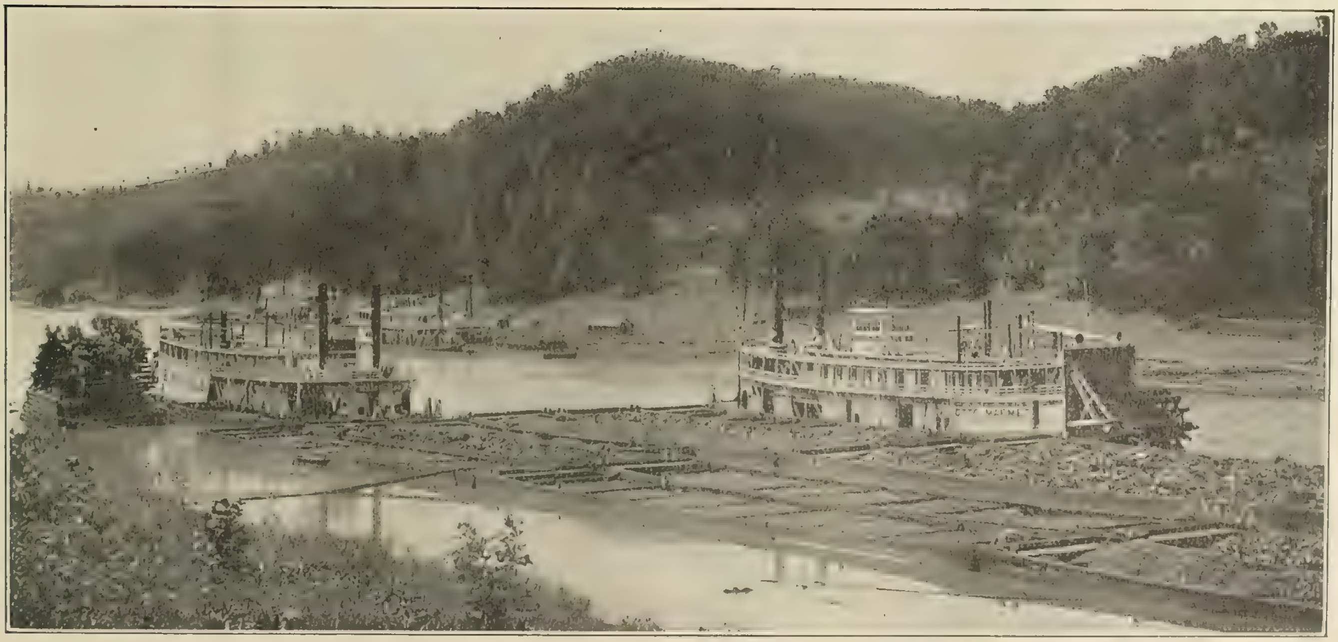


FIG. 10.—COAL LANDINGS ON KANAWHA RIVER WITH TOWBOATS AND FLEET OF BARGES

Modern German Stern-Wheel Steamers

BY E. VAN DER WERF

On the Elbe, Oder and Weichsel Rivers and their tributaries a large number of stern-wheel steamers are in service, most of which are used as tugs. The building of this type of vessel in Germany has now reached a high degree of efficiency, as can be seen from the plans of the steamer accompanying this article. The steamer illustrated, which is a representative stern-wheel type, has the following dimensions:

	Feet
Length over all	153.5
Beam, molded	19.0
Depth at side	6.3
Highest fixed point above light draft	9.8
Draft with 10 tons of coal	2.13

The hull is built of Siemens-Martin steel with angle-bar frames spaced 24 inches apart. Web frames are fitted where the size of the hold necessitates further stiffening. The thickness of plating and general construction can be seen from the drawings. The rudder is of the balanced type.

Vessels of this type are not built on an even keel, the bottom having a curvature according to the distribution of the different weights of the vessel, thus avoiding by the change of form an increase of draft in loaded condition.

Floors are arranged on alternate frames in the cargo spaces, while in the engine and boiler spaces the scantlings of the floors are increased, and they are fitted on every frame. One

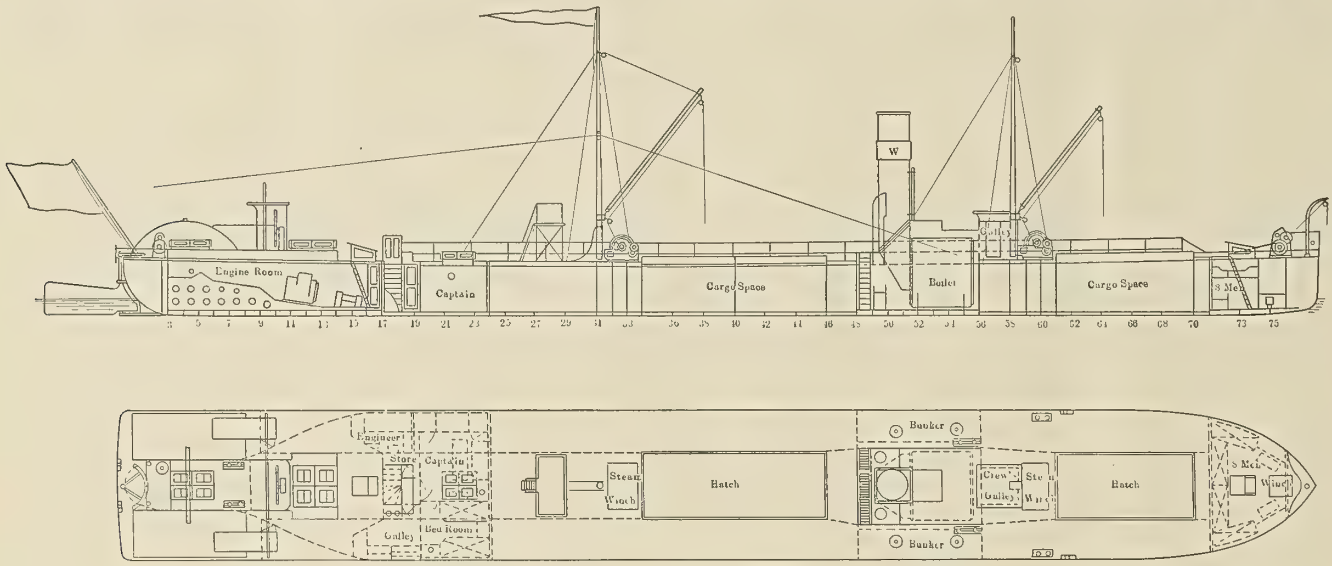


FIG. 1.—PROFILE AND DECK PLAN OF TYPICAL STERN-WHEEL STEAMER ON GERMAN RIVERS

FIG. 2.—MIDSHIP SECTION

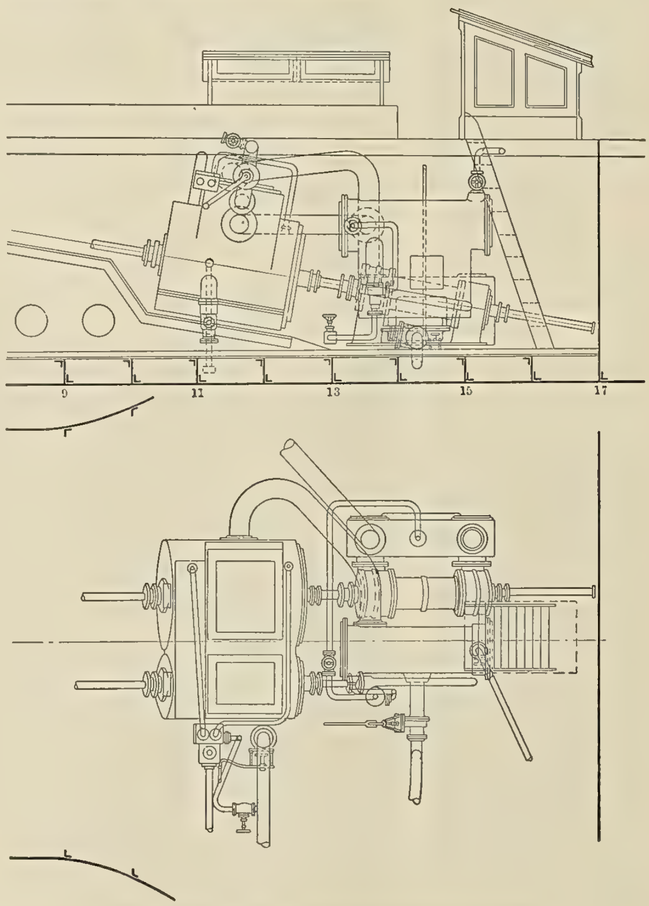


FIG. 3.—ELEVATION AND PLAN OF ENGINE ROOM

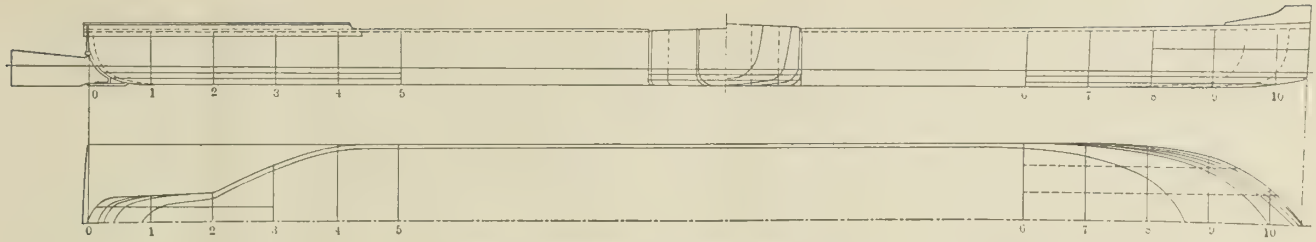


FIG. 4.—LINES OF HULL SHOWN IN FIG. 1

intercostal keelson is fitted on each side of the vessel, the scantling being increased in both the engine and boiler rooms.

The shape of the vessel at the stern is drawn in so as to leave room on each side for the double paddle-wheels, which are of the most approved design, with nine feathering curved iron paddles, about 5 feet in length and 2 feet wide. The use of feathering wheels and curved paddles has been found to give the best efficiency for this type of shallow draft vessel.

The hull is divided into seven compartments by six 'thwartship bulkheads; the extreme after compartment is reserved for stores, while the compartment forward of it is the engine room, having its entrance through a companionway on deck. The engine is of the inclined compound type, arranged as shown in Fig. 3, with cylinders 18.2 and 32 inches diameter and a stroke of 37.6 inches. The engine indicates about 225 horsepower.

The third compartment from the stern contains the living quarters for the captain and engineer as well as the galley and pantry. The entrance to this compartment is from the deck, while the engineer has a separate entrance to his room directly from the engine space.

The next compartment is reserved for cargo and the next beyond is taken up by the boiler and bunkers. The boiler is 7.8 feet long, 8.85 feet diameter, fitted with two furnaces and having a total heating surface of 936.5 square feet. The boiler is designed for a working pressure of 118 pounds per square inch.

The compartment forward of the boiler room is reserved for cargo, while the crew's quarters are arranged forward of the forward collision bulkhead.

The masts, booms and necessary gear for handling cargo are arranged as shown in the drawings. Besides carrying freight, the steamer is used also as a tug, the tow line running through an iron block attached to the after mast to bollards on either side of the boiler enclosures.

The weights of the vessel and her machinery are as follows:

	Tons
Plates (including rivets)	44.5
Angles (including rivets)	17.0
Forgings	4.0
Wood	13.0
Outfit	10.0
	88.5
Engine	18.0
Boiler	13.2
Water in boiler and pumps	6.5
Coal	12.0
	138.2
Displacement margin	6.6
	144.8

Another type of stern-wheel steamer is in service, principally on the Weser, in which the after part of the vessel is drawn together for a longer distance in order to allow for the arrangement of the engine and boiler in one compartment. With this arrangement no fireman is required, as the engineer can take charge of both the boiler and the engine. The centers of the wheels are located about 26 feet from the stern, and the normal shape of the hull is resumed at a point about 46 feet from the stern. Water tanks are provided in the forebody of the hull for trimming the vessel on an even keel when unloaded.

The dimensions of these vessels are:

	Feet
Length between perpendiculars	187.0
Beam, molded	25.6
Depth at sides	7.2
Draft with 250 tons of cargo	3.94

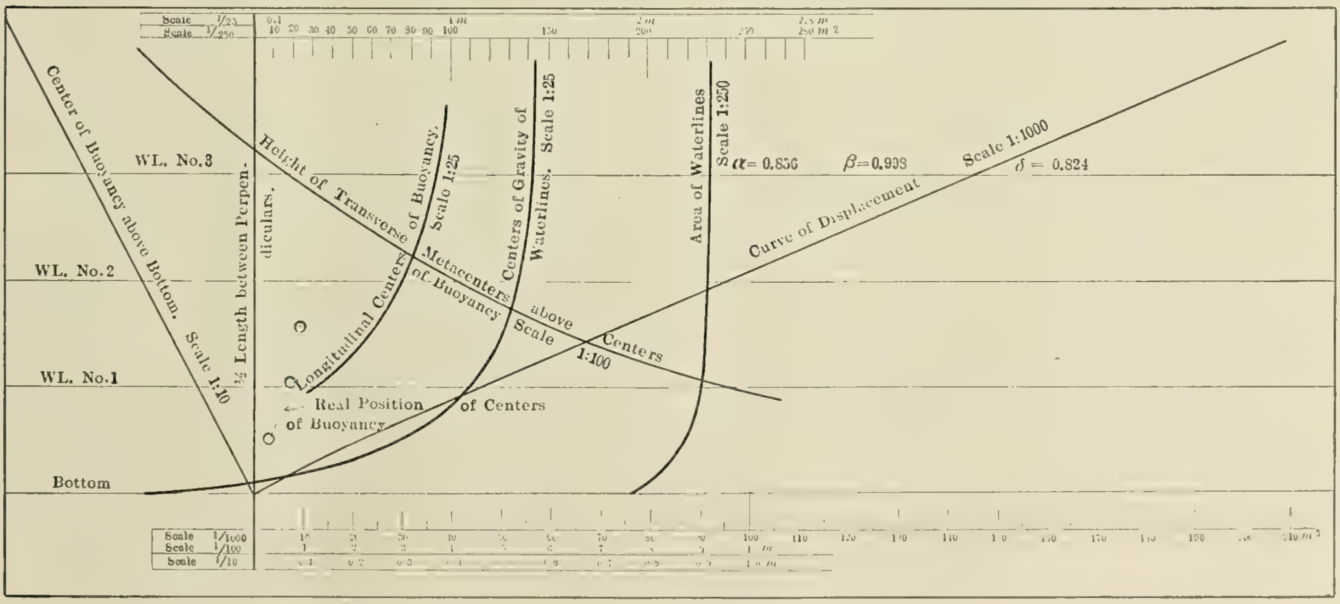


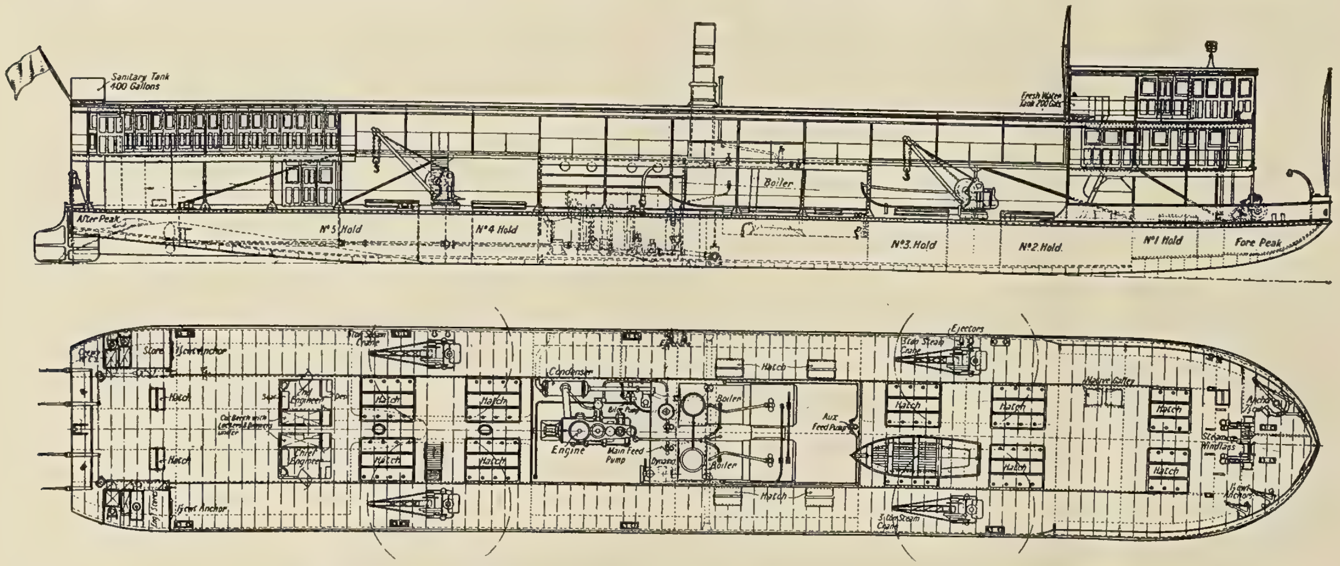
FIG. 5.—CONSTRUCTION DATA FROM THE DESIGN SHOWN IN FIGS. 1-4

The engines are of the compound type, with cylinders 14 inches and 26 inches diameter with a stroke of 40 inches, developing about 180 horsepower. The boilers are of the cylindrical type, about 100 inches diameter by 108 inches long, with a heating surface of 753.5 square feet. The wheels, fitted with nine paddles, are of the feathering type, as in the other vessels.

Shallow Draft Oil Steamer Comte de Flandre

One of the largest vessels ever built on the raised propeller system is the steamer *Comte de Flandre,* built by Messrs. Yarrow & Company, Ltd., Scotstoun, Glasgow, to the order of Messrs. Lever Bros., Ltd., of Port Sunlight. The vessel is designed to run on the Congo to bring oil from the upper reaches down the river, the designs and the work having been carried out under the supervision of Messrs. Esplen & Sons, of Liverpool. The length of the hull is 190 feet, the beam 30 feet and the molded depth 8 feet.

The raised propeller system, which has been incorporated in the design, is now so well known that an extended description is unnecessary. It is sufficient to refer to previous shallow draft numbers of this journal to obtain full particulars. Briefly, the raised propeller system consists of having the screw placed in an inverted tunnel, the after part of which is hinged so that the extreme after end of this hinged flap can impinge upon the water at whatever draft the boat may be loaded to, so that the action of the propeller in the tunnel will expel the air from the tunnel and enable the propeller to work in what is called "solid" water without causing undue resistance by the too deep immersion of the after end of the tunnel.



OIL CARRIER COMTE DE FLANDRE, BUILT BY MESSRS. YARROW FOR SERVICE ON THE CONGO

The hull of the *Comte de Flandre* is divided into ten compartments, the propelling machinery being placed amidships. Forward are three holds having a total capacity of 10,080 cubic feet, while aft are two holds with a total capacity of 11,950 cubic feet. Altogether the boat has a total deadweight cargo capacity of 250 tons. When fully loaded the draft of the vessel is only 4 feet 6 inches, at which the estimated speed is 10 knots.

Accommodation is provided for ten first class passengers on the spar deck aft. The dining room, with adjoining galley, is forward, above which are quarters for the captain and manager.

The propelling machinery consists of a single set of triple-expansion engines, built by Messrs. Yarrow. The high and intermediate-pressure cylinders are fitted with piston valves and the low-pressure cylinder with a flat double-ported slide valve. Steam is supplied by two locomotive type boilers, constructed by the North British Locomotive Company, of Glasgow. As wood is used for fuel these boilers are fitted with large tubes and specially large fireboxes.

The auxiliaries include an electric plant and a full equipment of pumping appliances. In addition to a steam winch for working the anchor and warping the ship around bends in the river, the deck machinery includes four 3-ton steam cranes for handling freight, each crane serving two holds.

Assessment of Panama Tolls by Net Tonnage Measurement an Injustice

It is not often that International Marine Engineering deviates from its text of engineering in the marine field, but the United States Government has so bungled the subject of tolls in the Panama Canal that we feel it a duty to protest. A thoroughly scientific manner of assessing tolls was presented to the Congressional committee having the subject in charge and also to the President of the United States, but for some reason unknown to the public the old unreliable method of basing tolls on net tonnage was adopted. Net tonnage means little, if anything, depending upon the man who uses it. It is like figures which cannot lie as much as the man who uses them. Net tonnage works an injustice to some people and gives other people more than they are entitled to, especially if they wish to be tricky. Instead of simplifying the assessing of tolls it complicates them. The policy adopted by the Government opens the door to fraud upon the Government and the ship owner. Instead of being honest and perfectly fair to both sides it deliberately drives shipbuilders and ship owners to subterfuge and petty trickery to get around the law. The action taken by the United States Government is a serious reflection upon American engineering ability and a great step backwards in these days of scientific attainments.

Shipbuilding Returns.—The Bureau of Navigation reports 101 sailing, steam and unrigged vessels of 30,854 gross tons built in the United States and officially numbered during the month of September. For the three months ending Sept. 30, 376 sailing, steam and unrigged vessels of ·0,222 gross tons were built as compared with 485 vessels of 80,281 gross tons built during the same quarter a year ago. The increase this year is general throughout the country.

FIG. 1.—FIRST OF THE FIFTEEN PRODUCER GAS BARGES BUILT FOR THE ALABAMA-NEW ORLEANS TRANSPORTATION COMPANY

Shallow-Draft Producer Gas Motor Barges

Fifteen steel producer gas motor barges, designed to carry 1,000 tons cargo on a draft of 6 feet at a speed of 7 miles per hour, were ordered several months ago from the Great Lakes Engineering Works, Detroit, Mich., by the Alabama-New Orleans Transportation Company for service between the Black Warrior Coal Basin in Alabama and New Orleans. The waterway on which these barges will ply covers a total distance of about 515 miles through the Black Warrior, Tombigbee and Mobile Rivers, the Mississippi Sound and the Lake Borgne Canal. The mines in the Black Warrior Basin produce about 6,000,000 tons of coal per year, all of which up to the present time has been carried by rail to New Orleans at a cost, including switching and terminal charges, of about $1.30 (5/5) per ton. Transportation of this coal by water, it is estimated, can be accomplished at a rate of $1.20 (5/0) per ton with a fair profit. The barges will be used exclusively for carrying coal from the Black Warrior mines to New Orleans, the return cargoes consisting of scrap iron and Cuban ores.

A shipyard for the construction of the barges was erected on Lake Borgne Canal about 10 miles north of New Orleans. Three of the barges were launched early in the summer and one was completed and placed in commission in July. After a thorough trial of the first barge work on the remaining vessels has been pushed forward rapidly so that one barge could be delivered every four weeks.

The barges are 240 feet long, 32 feet beam and 8 feet deep. They are built of steel throughout with one bulkhead aft of the forecastle and one forward of the engine room. The propelling machinery is placed in the stern, and the deck is free of hatches, as the barges are designed to carry the entire load on the deck. The crew is berthed in the forecastle, while the galley and pilot-house are placed aft over the machinery space.

Propulsion is by two three-cylinder special marine gas engines of 75-brake horsepower each, driving right and left-hand propeller wheels made of semi-steel 46 inches diameter, 2 feet 9 inches pitch, with a developed area of blades of 6.67 square feet. The engines are designed to develop their estimated power at a normal speed of 300 revolutions per minute.

The fuel is producer gas made from "coke breeze" in a

FIG. 2.—PRODUCER GAS BARGE UNLOADING AT NEW ORLEANS

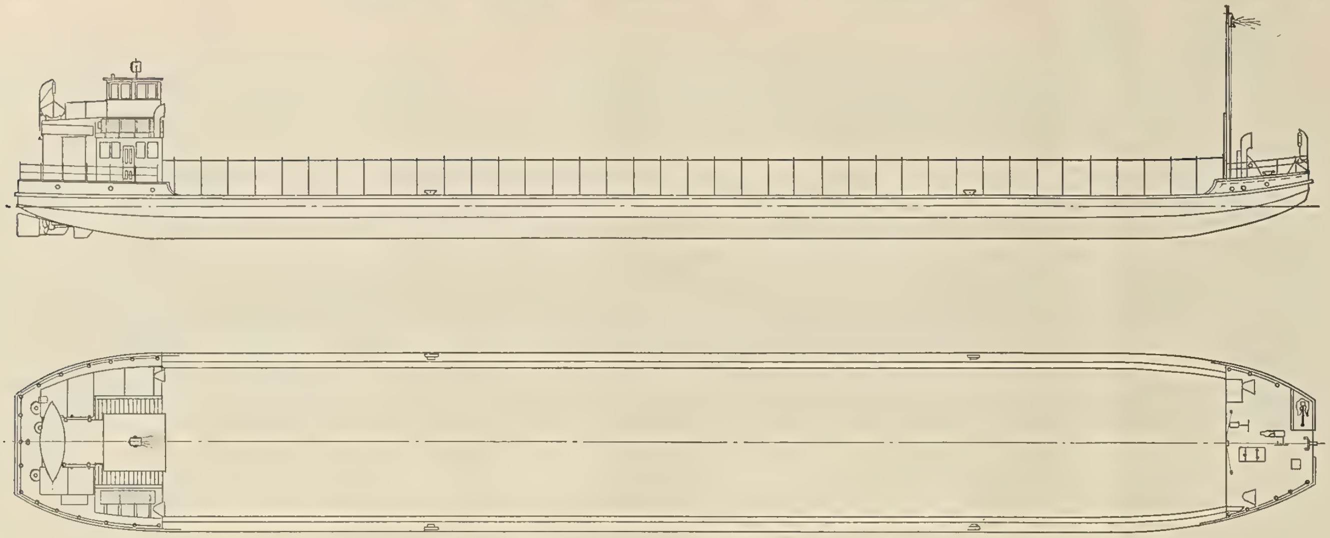


FIG. 3.—GENERAL ARRANGEMENT PLANS OF PRODUCER GAS BARGE

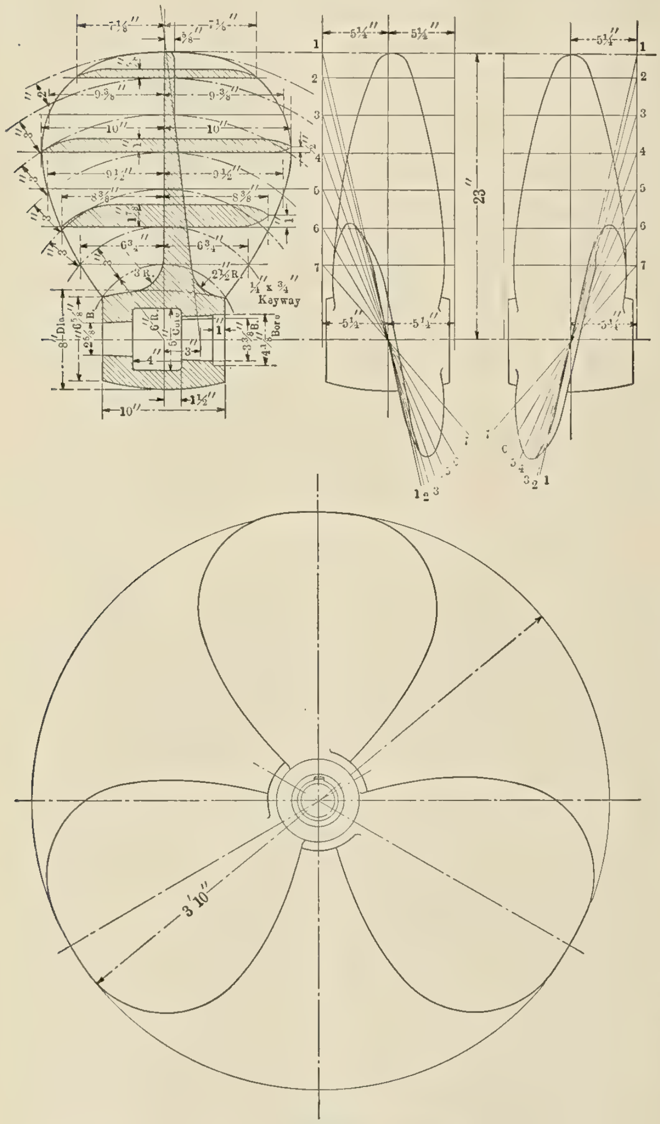


FIG. 4.—PROPELLER DESIGN

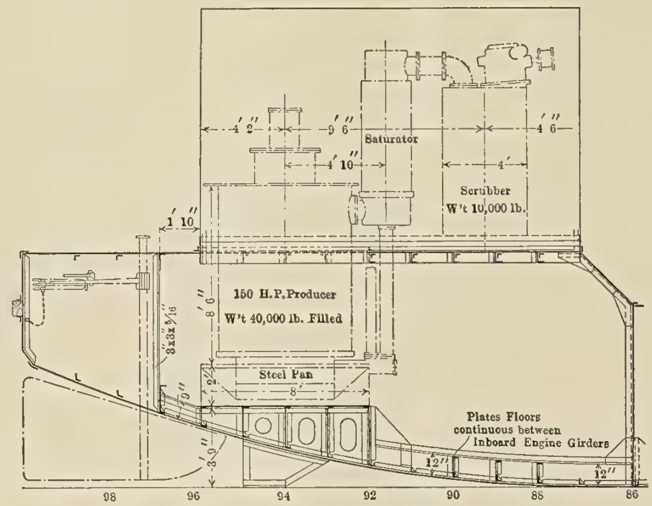


FIG. 5.—ARRANGEMENT OF GAS PRODUCER

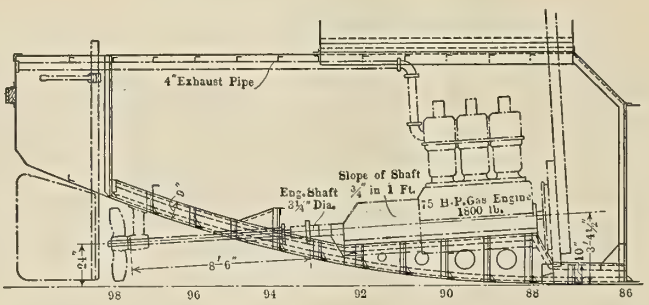


FIG. 6.—SECTION SHOWING PORT ENGINE

single producer, with the usual equipment of saturator, scrubber and tar extractor. "Coke breeze" is the waste coke from the coke oven, consisting of fine, small particles of coke which cannot ordinarily be used in commercial practice, but which it is found makes a splendid fuel for a gas producer. The total cost of fuel to supply the engines with gas averages about $2 (8/4) per twenty-four hours.

The arrangement of the gas producer and its accessories, together with the main and auxiliary engines, can be seen from the sections shown in Figs. 5, 6 and 7. One of the main engines is connected by friction wheels to a 5-inch ballast pump, while the other engine is arranged to drive in a similar manner a small electric generator. An auxiliary gasolene (petrol) engine is provided to furnish power for the electric generator when the vessel is in port. There is also a small air compressor for supplying the necessary air for starting the main engines. The windlass, forward, is driven by electricity, and the barge is steered by hand.

The steering of the barges, it is claimed, is a very easy task. The vessel responds to the wheel as readily as a yacht, and is under complete control every moment, in spite of the unusual proportions of the hull and the novel arrangement of the machinery.

The successful solution of the problem of constructing a self-propelled barge equipped with gas engines operating on producer gas generated from the cheapest kind of fuel obtainable is worthy of note. On trial the first barge completed made an average of 8½ miles per hour loaded, although the guaranteed working speed while carrying 1,000 tons on a 6-foot draft was only 7 miles per hour. The maximum speed attained on trial was 8.9 miles per hour, the conditions as to wind, etc., being normal.

In order to determine in advance the success of the gas producer and gas engine outfit as applied to marine work, exhaustive experiments were carried out by the builders prior to the installation of the gas producer equipment in the boat. The design of the propeller wheels was investigated very thoroughly, as it was realized that the general dimensions, pitch, blade area and shape of the blades would have a very important bearing upon the success of the propelling machinery. The details of the design adopted are shown in Fig. 4, one of the wheels being right-hand and the other left-hand.

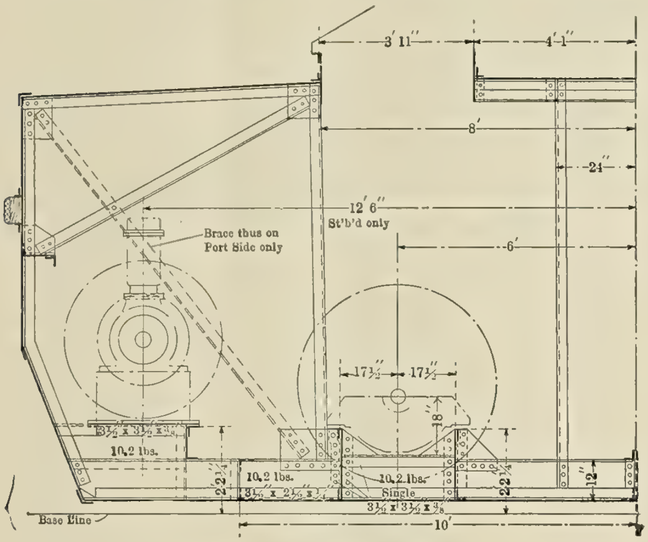


FIG. 7.—SECTION AT FRAME 90

In making the propellers, special attention was given to obtaining the true pitch and a perfectly balanced wheel when running. When it is considered that the extreme diameter of these wheels is 46 inches, and that they are run at a speed of 300 revolutions per minute in a very light craft, the accuracy sought in the design and construction of the propellers will be fully appreciated as being of paramount importance, and it is pleasing to learn that the results with these wheels have been satisfactory in every respect.

International Conference on Safety at Sea.—The United States will be represented at the International Conference on Safety at Sea in London on Nov. 12 by the following delegates: Representative J. W. Alexander of Missouri, chairman of the Committee on Merchant Marine; Senators Fletcher of Florida and Burton of Ohio; E. T. Chamberlain, Commissioner of Navigation; Commandant E. P. Bertholf, Revenue Cutter Service; Rear Admiral Washington L. Capps, formerly Chief Constructor of the United States Navy; Capt. George F. Cooper, hydrographer of the navy; Capt. W. H. G. Bullard, superintendent Naval Radio Service; Homer L. Ferguson, general manager Newport News Shipbuilding & Dry Dock Company, Newport News, Va.; Albert Gilbert Smith, vice-president of the New York & Cuba Steamship Company; Andrew Furuseth, head of the Seamen's Union, and George Uhler, Supervising Inspector-General of the Steamboat Inspection Service.

Motor Gunboats for Colombia

Three motor gunboats, driven by gasolene (petrol) engines of the Yarrow-Napier type, have recently been built by Messrs. Yarrow & Company, Ltd., Scotstoun, Glasgow, for the Colombian Government, to be used for coastal defense. These boats are of considerable interest just now, not only on account of the fact that they are among the first motor gunboats ever put in commission for coastal defense duties, but also on account of the fact that the British Admiralty is seriously considering the question of employing yachts fitted with light armament as an auxiliary to the navy.

These boats were erected and bolted together in Yarrow's shipyard, and then taken to pieces and sent out in knock-down form, two to Cartagena and one to Buenaventura. The first boat shipped to Cartagena is now running very successfully; the second one at the time of writing is on the point of being launched, and the third one, at Buenaventura, is being reconstructed at that port. The main dimensions are: 80 feet length between perpendiculars, 12 feet 6 inches molded breadth, and 5 feet 8 inches molded depth.

MOTOR GUNBOAT FOR COLOMBIAN COASTAL DEFENSE

The main propelling machinery in these boats consists of two Yarrow-Napier four-cycle gasolene (petrol) engines, each of about 60 horsepower, of the four-cylinder type similar to those fitted in the *Yarrow-Napier*, which was built some years ago for the British Admiralty by Messrs. Yarrow. For small vessels, and particularly for government duties, where expensive fuel is not a very important consideration, these engines have certain advantages over other types. The draft of the vessels is under 3 feet 6 inches, and they are fitted with keels of the flat plate type in order to enable them to run in shallow water. The starboard engine only is fitted with reversing gear, as this is considered quite sufficient for maneuvering purposes, and, furthermore, simplifies the machinery. The fuel is carried in two tanks, 8 feet 6 inches long and 4 feet 6 inches diameter, of 900 gallons capacity each, which gives a radius of action at 12 knots of about 2,400 nautical miles.

The armament consists of a single quick-firing gun of 47 millimeters bore mounted on the forward deck. This is considered sufficient for the purposes for which the boats are required, as they are not expected to take any part in resisting a formidable attack but only to be capable of resisting landing parties or pirates. They are also to be used for custom house purposes to prevent smuggling. Each boat is fitted with a powerful searchlight for the purpose of detecting any landing parties in the creeks which abound on the coast.

Side Wheel Ferry Leschi

A new steel side-wheel ferry is now being completed by Messrs. J. F. Duthie & Company, of Seattle, Wash., for the port of Seattle. The vessel is for use on Lake Washington, and will accommodate the rapidly-increasing traffic between the city and the districts across the lake, a distance of about 3 miles.

The designs were prepared by Mr. Fred A. Ballin, of Portland, Ore., and the construction is under the supervision of Mr. L. E. Geary, of Seattle. The contract price was $85,000 (£17,400).

The principal dimensions of the boat are as follows:

Length over all	169 feet
Length between perpendiculars	152 feet
Breadth, molded	33 feet
Breadth over guards	52 feet 4 inches
Depth, molded	8 feet 9 inches
Draft, fully equipped	4 feet 9 inches

The hull to the main deck is built of mild steel, and is divided transversely by three watertight bulkheads and one partial bulkhead, forming the fuel oil bunker. The hull is strengthened longitudinally by keelsons and stringers and by a pair of trusses extending from end to end. The engine and boiler seatings are strongly built up, and so designed that the strains are distributed over a long section of the bottom. The wheel and guard beams are of steel, and the superstructure is of wood as well as the main deck beams which support the roadbed for vehicular traffic.

The ferry is double-ended, with balanced rudders at each end controlled from two pilot houses. The main deck is chiefly given up to vehicles, of which forty or more can be accommodated. At the sides are toilets and smoking rooms, while the machinery space separates the two roadbeds, which are paved with asphaltum and have 12 feet clear headroom. The main cabin is situated on the upper deck, and is fitted with stationary settees to accommodate 300 passengers.

The machinery consists of a pair of high-pressure inclined engines, the cylinders of which are 16 inches diameter, with a stroke of 72 inches, designed to work at 40 revolutions per minute. The main shafts are 9 inches diameter, and drive feathering paddle-wheels measuring 15 feet over the buckets. The designed power of 700 indicated horsepower is expected to give a speed of 14 miles.

Steam is supplied by a Ballin watertube boiler of 4,000 square feet heating surface, working at 250 pounds per square inch with oil for fuel. In addition to this a large vertical donkey boiler is placed on the main deck. The exhaust steam from the engines may be either led to the smokestack or condensed in a specially designed exhaust ejector.

The auxiliary machinery consists of outside-packed, pot-valve Burnham feed pumps, a bilge and fire pump, sanitary pump, etc. The ferry is lighted by electricity throughout, current being furnished by a 7½-kilowatt Terry turbine set and a 2-kilowatt set of the same make for day lighting. Searchlights are placed on the top of each pilot-house. Steering wheels in each pilot-house connect with a Hyde steam steering gear in the engine room, arranged to work either rudder.

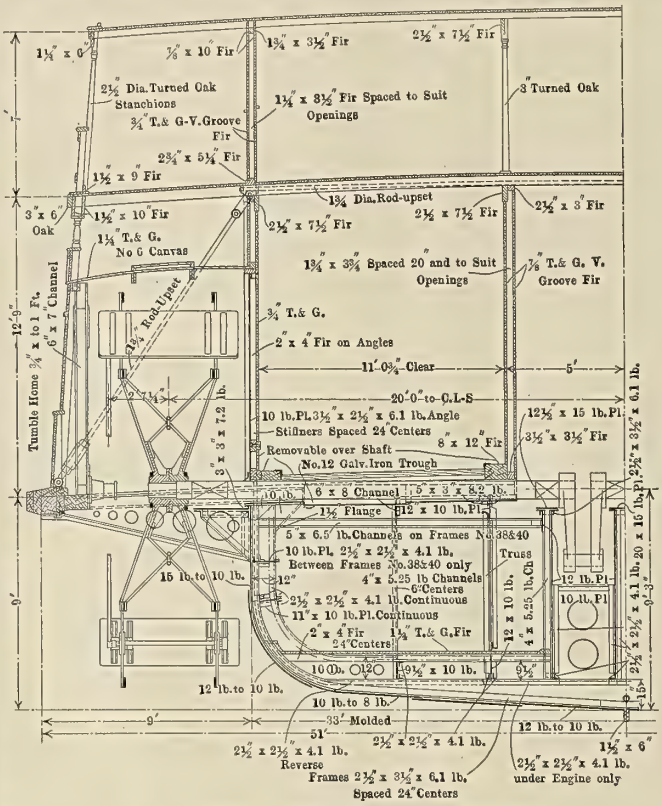


FIG. 2.—MIDSHIP SECTION, SHOWING SCANTLINGS

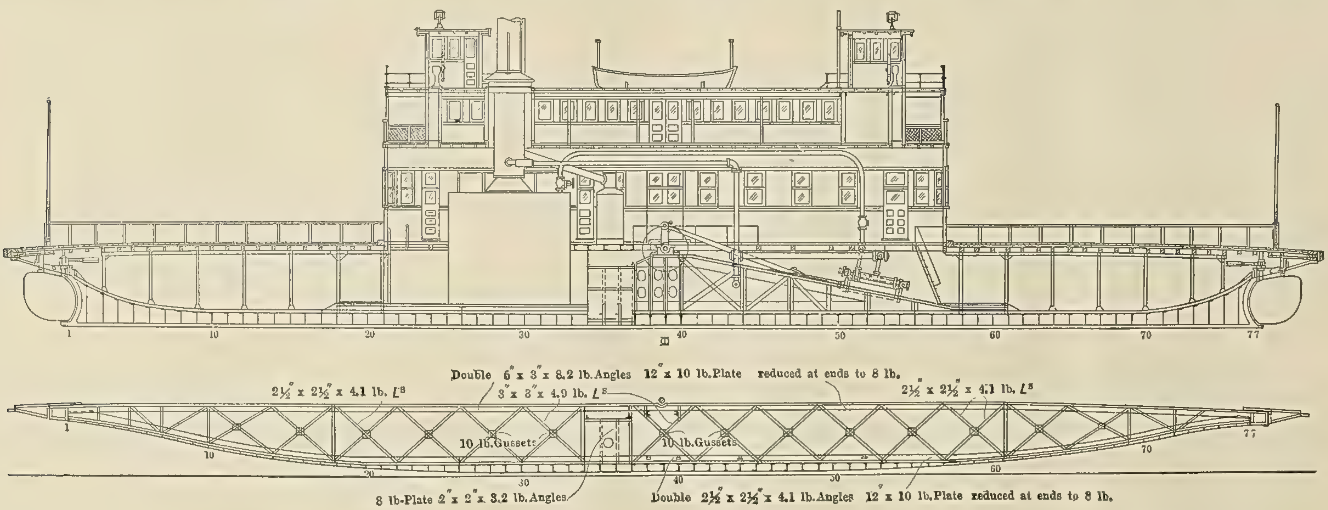


FIG. 1.—INBOARD PROFILE AND SECTION THROUGH LONGITUDINAL TRUSS OF LAKE WASHINGTON FERRY

The steam gear can be converted into a hand gear from each pilot-house in case of accident.

The hull of the *Leschi* was completed in the yards of Messrs. J. F. Duthie & Company within two months after receipt of the material from the East. All the steel work was riveted in suitable sections, then knocked down and sent across to Lake Washington by car, where it was re-erected and the riveting completed.

Armored River Monitors for Brazil

BY F. C. COLEMAN

Three armored monitors, the *Javary, Solimoes* and *Madeira* are being built by Messrs. Vickers, Ltd., at the Naval Construction Works, Barrow-in-Furness, for the Brazilian Government. These vessels, the first of which, the *Javary,* was launched on June 17, have each the following dimensions: Length, 265 feet; breadth, 49 feet; depth, 8 feet 6 inches; mean draft, 4 feet 6 inches, with a displacement of 1,250 tons. The vessels were designed for a speed of 11½ knots and will have a radius of action at an economical speed of 4,000 nautical miles.

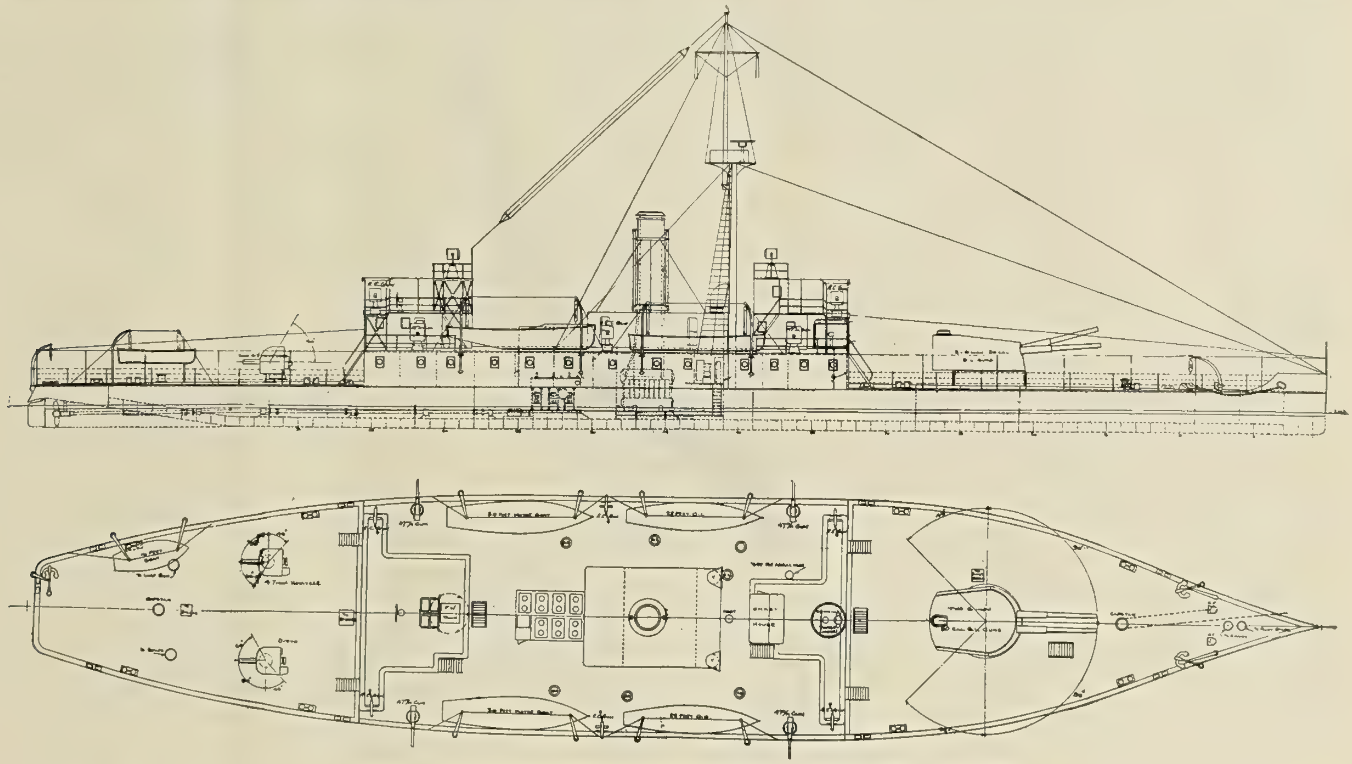
Primarily intended for river work, the vessels are each fitted with a double bottom extending almost the entire length of the ship, stowage being provided between the double bottoms for feed water, oil fuel for the boilers, etc. This double bottom construction is continued up the sides of the ship to the upper deck in way of the engine and boiler spaces and magazine, adding to the safety of the ship. The hull is also separated into a large number of watertight compartments by transverse and longitudinal bulkheads extending up to a complete steel upper deck. These compartments form the various store rooms, magazines, bunkers, auxiliary machinery spaces, etc.

The armament, which is of the Vickers type, consists of two quick-firing guns mounted in one armored turret on the upper deck forward and with electrical machinery for working the guns; two 4.7-inch howitzers on the upper deck aft; four 47 mm. quick-firing guns on the boat deck; and six R. C. guns on the boat deck and on the forward and navigating bridges. Suitable fire control arrangements for the guns are provided. Two powerful searchlight projectors are fitted, one forward and one aft, and these are arranged to be controlled from a suitable position on the forward navigating bridge.

The sides of the vessel amidships for a very considerable part of the length of the hull are armored by heavy plating of the latest type, extending from the upper deck to well below the waterline. Forward and aft of this belt are armored bulkheads, extending the same distance below the waterline as the side armor. The remaining portions of the vessel's sides, including the stern, are protected by thinner armor. The upper deck is of nickel steel armor forming protection to the various compartments. In the heavily armored conning tower are all appliances for working the guns, etc., and for controlling the vessel, and all communication wires, steering rods, etc., are placed within an armored communication tube.

The propelling machinery consists of two sets of vertical inverted direct-acting triple expansion engines, each set being complete with its own independent and separate surface condenser. Each set of engines has three cylinders working on separate cranks, placed at angles of 120 degrees with each other, and particular care has been taken in the design of the machinery for the balance of the various reciprocating parts.

The engines are designed to run at about 250 revolutions per minute with a working pressure of 250 pounds per square inch at the boilers, and 230 pounds per square inch at the engines. The diameter of the high-pressure cylinder is 11½ inches, the intermediate-pressure 18 inches and the low-pressure 18½ inches, the length of the stroke being 17 inches in each case.



PROFILE AND WEATHER DECK PLAN OF BRAZILIAN ARMORED RIVER MONITORS

The cylinders are of strong cast iron bolted together and forming a steam joint for the receivers, and are supported at the back and front on turned steel columns. The distribution valves are of the piston type for the high-pressure and intermediate-pressure cylinders and of the flat, double ported form for the low-pressure cylinders, separate liners being fitted for the high-pressure and intermediate-pressure valves and a loose face for the low-pressure valve, which is also fitted with a balance piston. All of the valves are actuated by double eccentrics and link motion, and are fitted with steam reversing gear of the "all round" type in addition to the usual hand gear.

The two condensers are arranged in the wings of the ship; they are cylindrical in form with the casings built up of steel plates and angles with gun metal waterway and cast iron doors. The circulating water is supplied by two pumps of the centrifugal type driven by independent single-cylinder engines of the enclosed forced lubrication type. The main air pumps are independent and of the monotype pattern, one for each condenser.

The shafting is of mild steel throughout. The propellers are four-bladed, of bronze, the bosses and blades being cast solid. The propellers, which are arranged to turn outwards when going ahead, work in a tunnel in order to secure complete immersion under the light draft conditions.

Steam is to be supplied by two watertube boilers of the Yarrow type, and arranged for burning oil fuel in conjunction with coal. The feed water is supplied to the boilers by one main and one auxiliary feed pump of the direct-acting type and grease filters of the pressure type are fitted between the pumps and the boilers.

Distilling and evaporating machinery is supplied, and an oil fuel pump and air compressor are fitted in the boiler room in connection with the oil fuel system. There is a fire and bilge pump in the engine room. The See's ash ejector is supplied with a separate pump, which is also adapted for bilge purposes. A separate ash tube is fitted with hand hoisting gear for emergency use.

FIG. 1.—ENGINES FOR THE RIVER STEAMER ALASKA PARTIALLY ASSEMBLED IN THE BUILDERS' SHOPS

The magazines are ventilated and cooled on the thermotank system. An ice-making plant is also provided, and for the cold storage of meat and perishable goods there is an insulated compartment fitted with brine grids.

A boat deck is built above the upper deck, forming a superstructure in which the officers are accommodated. Pantries and lavatories are also built within this superstructure. On the boat deck accommodation is provided in steel deck houses for the commander and navigating officer. The commander's apartments include a commodious reception room and are handsomely decorated throughout. Messing and sleeping accommodation for the crew, including sick bay, dispensary, cockpit and operating room, are arranged in the forward part of the vessel below the upper deck. Sleeping accommodation is also arranged on the upper deck for troops. The complement is expected to be 100 officers and men.

Special attention has been given to both the natural and artificial ventilation of the vessel to give abundant supply of fresh air, in view of the extremely warm climate and great humidity of the atmosphere in the district in which the ship has to serve. The mechanical ventilation is carried out by means of ventilating fans worked by electric motors and all habitable and semi-habitable spaces, such as the various storerooms, etc., are provided with a very active circulation of air. The whole of the living quarters, including even those situated above the upper deck, are provided with electric ventilators so as to maintain an efficient circulation of air.

The electric power is derived from two sets of electric generators, one of which is driven by steam engines and the other by kerosene (paraffin) motors, the latter being capable of the full duty required when the boilers are not under steam. An installation of electric lighting is fitted throughout, and auxiliary lighting is provided for places where it is entirely indispensable, notably for ship's lights, lanterns, etc.

Steam steering gear of the latest pattern for the twin rudders is installed under the upper deck, capable of being actuated from the navigating bridge and conning tower. A steering wheel for emergency and steering is also provided.

A steam capstan is fitted forward, and for mooring operations and assistance in the work of turning the vessel round a capstan driven by kerosene (paraffin) engine is placed aft.

The vessel will have one mast and one funnel. The mast is fitted up with rangefinder platform and is made suitable for taking a wireless telegraph installation. Two navigating bridges extending the full breadth of the boat deck are fitted, with a commodious chart house of steel on the forward bridge.

Yukon River Boat Alaska

Navigation on the Yukon River is limited to only a few months each year, and this fact, coupled with the length of the waterway, makes it desirable to use comparatively high-speed boats in this service, so that as much freight as possible can be transported when the river is open to navigation.

The first vessel of the past season to reach Fairbanks from Whitehorse, a distance of over a thousand miles from the mouth of the Yukon River, was the Seattle-built steamboat *Alaska,* making the trip in five days and twenty-one hours. The White Pass & Yukon Railroad, owners of the vessel, constructed last winter two new river steamers in Seattle, which were shipped north in knocked-down form and erected at Whitehorse, where they were launched at the opening of navigation on the river.

One of these boats, the *Alaska*, is 160 feet long and 32 feet beam, provided with ample accommodations for passengers as well as for freight. Propulsion is by a stern wheel, driven by engines 16 inches diameter by 72 inches stroke, fitted with

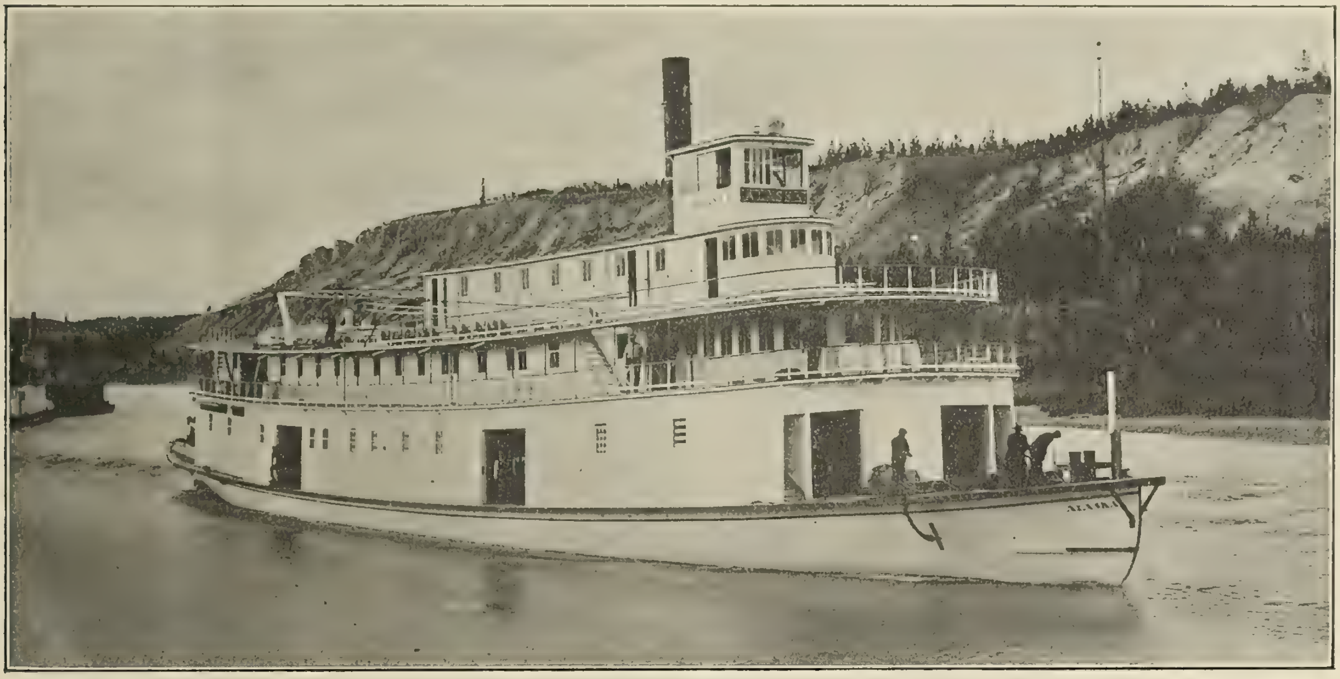


FIG. 2.—THE ALASKA

piston valves, Meyers' cut-off valves and double-bar links. The engines were built by the Seattle Machine Works, Seattle, Wash., the various parts of the engines being shipped as quickly as they were finished without being assembled in the builders' shops. The wheel shaft is 11 inches by 26 feet long, fitted with four 48-inch cast steel flanges and open-hearth forged steel cranks and pins. The pillar blocks are of cast steel. The main steam pipe is 6 inches diameter, extra heavy, with cast steel flanges shrunk on and riveted. The main exhaust pipe is 10 inches diameter, of light tubing with cast steel flanges riveted on. A slide throttle valve is fitted, balanced with a small auxiliary valve on top of the main valve.

Steam is supplied at a working pressure of 200 pounds per square inch from a locomotive firebox type boiler built by the Commercial Boiler Works, Seattle, Wash. The shell of the boiler is 63 inches inside diameter and 25 feet long over the smokebox. The firebox is 7 feet long, with a height of 6 feet 8 inches, and there are 222 2-inch outside diameter tubes, 14 feet long, making a total heating surface of 1,800 square feet. As wood is used for fuel on the boat, the grate surface is reduced to 15 square feet, the grate measuring 3 feet by 5 feet. The rest of the firebox is blanked off with dead plates. A horizontal steam drum, 30 inches diameter and 6 feet long, is fitted on top of the boiler, and connected to the shell with a 12-inch nozzle. The smokebox is 3 feet 7 inches deep, and is fitted with a wire spark arrester of four mesh. The products of combustion are carried off by a 30-inch smokestack extending to a height of 40 feet above the grate bars.

Placing fast steamers, such as the *Alaska*, in service between Whitehorse and Fairbanks on the Yukon River shortens the time for transportation between Puget Sound and Fairbanks by from ten days to two weeks as compared with previous service, and cannot fail to increase the trade of Puget Sound country with Alaska.

A Shallow Draft Tug Fitted with Six Propellers

BY F. MULLER VAN BRAKEL

In an article describing a single screw river tug published in the November, 1911, issue of INTERNATIONAL MARINE ENGINEERING, it was pointed out that the tugboats plying on the Rhine may be divided into two classes. The small single screw tugs up to 600 indicated horsepower bring lighters from Rotterdam to Duisburg and back, while farther up the river to Mannheim or even Strassburg the towing is done

FIG. 3.—DINING SALOON

mainly by big side wheelers of 1,000-1,500 indicated horsepower.

Last year a new type of tug was built in which are combined the advantages of both screw and paddle tugs. By arranging from 4 to 6 propellers on two lines of shafting, it was found possible to build a screw tug of 1,400 indicated horsepower on a 6-foot draft.

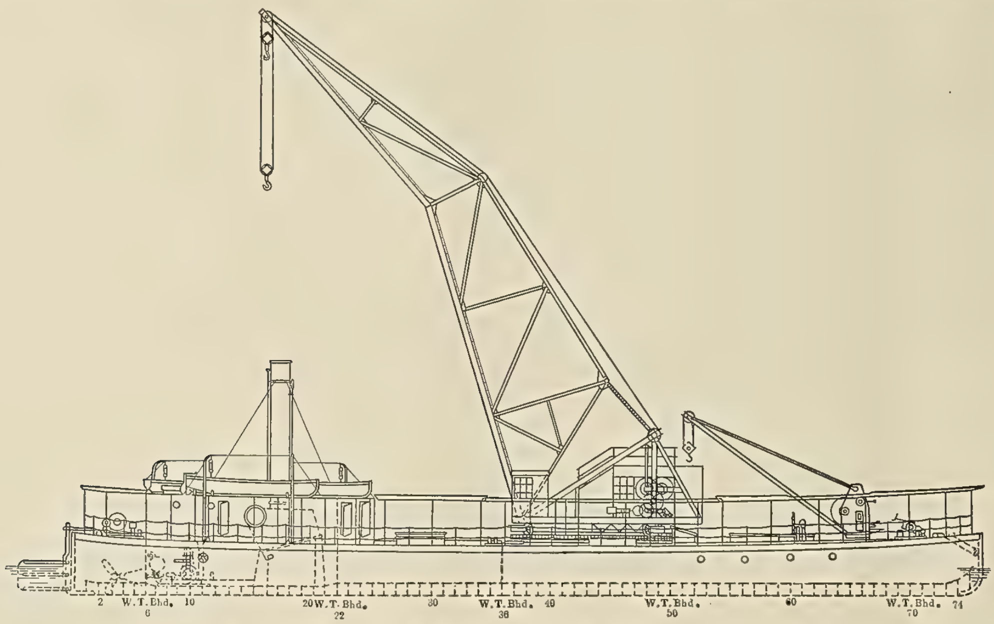
The boat, designed and constructed by Messrs. N. V. Scheepswerfvan P. Smit, Jr., of Rotterdam, for the well-known firm of Math. Stiunes, of Mülheim, has the following dimensions: Length, 156 feet; beam, 27 feet 6 inches; depth, 10 feet. The hull, which is built of steel, is divided into seven compartments—i. e., fore peak, cabin, boiler room, cross-bunker, engine room, crew space and after peak. The bunkers have a capacity of nearly 100 tons of coal. The equipment and outfit are very complete, including a steam windlass, steam steering engine and steam tow-rope winch.

Steam is supplied by two boilers, each having a heating surface of 2,045 square feet. They are fitted with Schmidt superheaters of the smoke tube type, and provide steam at 230 pounds pressure, superheated to 650 degrees Fahr. This steam is led to two triple expansion engines of the jet condensing type, each engine developing 700 indicated horsepower. The coal consumption proved to be very good, being as low as 1.27 pounds per indicated horsepower. When the superheaters are put out of action, the coal consumption rises to 1.57 pounds, still a very good record for engines of this class.

It is evident that no single propeller can be designed for 700 indicated horsepower on a 6-foot draft. The builders therefore decided to fit more than one propeller on each shaft. In order to secure the highest efficiency for each draft, two different sets of propellers are provided—i. e., one set of two propellers on each shaft for the normal draft of 6 feet 7 inches, corresponding to 90 tons of coal in the bunkers, and a set of three propellers of smaller diameter on each shaft for the light draft of 5 feet 7 inches, corresponding to 20 tons of coal in the bunkers, an arrangement which has proved entirely satisfactory.

Floating Salvage Crane

A self-propelled floating steam crane of 30 tons capacity is being constructed by Ritchie, Graham & Milne, Glasgow, for delivery at Rio de Janeiro, Brazil. The crane is mounted on a hull 150 feet long, 50 feet beam and 8 feet molded depth, built of steel according to Lloyds, with the necessary accommodation for officers, crew and two divers. The 30-ton crane and a 5-ton steam crane were supplied by Sir William Arrol & Company, Ltd. There is also a complete set of diving apparatus, a submarine exploding plant, and pumping apparatus supplied by Messrs. Siebe Gorman & Company, Ltd. The vessel is fitted with two sets of compound surface condensing engines, supplied with steam by two Babcock & Wilcox watertube boilers. After completion and trials the vessel will be prepared for a sea voyage to Rio de Janeiro.



SELF-PROPELLED FLOATING CRANE OF 30 TONS CAPACITY DESIGNED FOR SALVAGE WORK

Tunnel Stern Motor Passenger Vessel

A 95-foot twin-screw tunnel motor passenger boat was built recently for the Northern Steamship Company, of Auckland, New Zealand, by Messrs. John I. Thornycroft & Company, Ltd., Southampton, to be used for harbor and river service.

The boat was designed with light draft in order to enable it to pass over shallow bars. With a load of 10 tons the draft is 2 feet 3 inches, and at this draft the boat will be driven at a speed of 11 knots by two sets of Thornycroft S-4 type kerosene (paraffin) engines.

The machinery is placed amidships with cargo holds forward and abaft. A promenade deck with steel framing is fitted over the upper deck, giving ample space for passenger accommodations. An electric and hand windlass is fitted forward to work the ship's anchors and also for warping.

The vessel is lighted throughout with electricity, current being supplied by a separate generator worked direct off a kerosene (paraffin) motor. Combined in the same bedplate, and worked by the same motor, are the bilge pump and an auxiliary air compressor.

The hull is built of mild steel plates and angles, the shell plating being galvanized. After the trials were completed by the builders the vessel was hauled up, disconnected and shipped in knock-down form to New Zealand.

225-Ton Floating Crane

What is said to be the largest floating crane in the world is under construction by William Chalmers & Company, Ltd., Rutherglen, for use in the construction of the naval harbor Talcahuano, Chile. On a steel pontoon, 110 feet long by 70 feet wide by 12 feet deep, is mounted a non-revolving crane of 225 tons capacity at a reach of 90 feet. Powerful steam winches are provided for placing the pontoon in position and for slewing. The total displacement at maximum load at maximum radius will be 1,140 tons, including the ballast in the tanks to counterbalance the load.

This crane will be used by the contractors in placing large monoliths in position that are to form the sea wall and breakwater in the harbor of Talcahuano.

Twin Screw Passenger and Cargo Steamer St. Patrick

The *St. Patrick* illustrated on this page is a twin-screw passenger and cargo steamer of shallow draft, built by Messrs. John I. Thornycroft & Company, Ltd., at Southampton, to the order of the Crown Agents for the Colonies for service at Trinidad. The vessel was completed at the builders' works, and is now steaming out to her destination. In most respects she is similar to the *Naparima* built by Messrs. Thornycroft for the same service some years ago, but the new boat is considerably larger, her length being 180 feet, the beam 27 feet and the depth 7 feet. On a draft of 3 feet the vessel is propelled by two sets of triple-expansion engines, driving tandem twin screws housed in tunnels at the stern at a speed of 14½ knots.

TWIN-SCREW TUNNEL STERN STEAMER ST. PATRICK

The hull is built of steel and divided into seven watertight compartments by six athwartship bulkheads. Ample space for cargo is provided in the holds forward and abaft the machinery space. Passenger accommodation is arranged on the upper and promenade decks. Four cabins, suitable for the officers of the vessel, are at the forward end of the upper deck. The galley, dining saloon, lavatories, etc., are placed aft on the same deck, the promenade deck being given up entirely to the passenger accommodation.

The tunnel type of boat was adopted in order to reduce the weight to a minimum and to give the screws good protection in shallow water. Steam is supplied by a single water-tube boiler placed in an inclosed stokehold, the boiler being worked under forced draft. The rudders are worked by a steering engine placed at the after end of the engine room and controlled by a steering wheel fitted at the forward end of the awning deck. Four derricks are fitted for handling cargo, and two 18-foot lifeboats are slung from davits at each quarter.

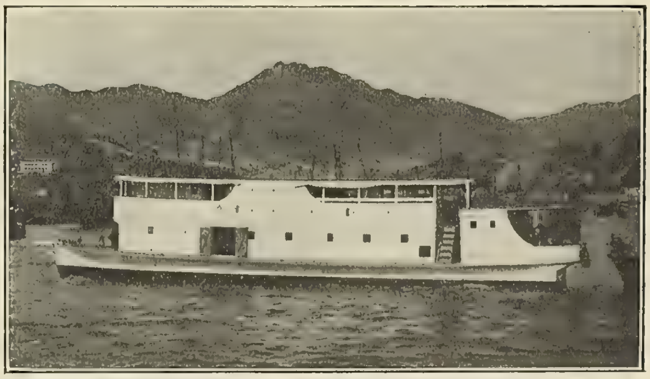
For the voyage out to her destination temporary wooden bulkheads and a turtle deck were fitted in order to ensure the vessel's seaworthiness.

Tunnel Stern Twin Screw Gasolene (Petrol) Towing Launch Yasica

During the last year the Gas Engine & Power Company and Charles L. Seabury & Company, Con., Morris Heights, New York City, designed and built for the Cuba Planters' Company a twin-screw tunnel-stern gasolene (petrol) launch for use as a towboat for towing banana barges and also for carrying their workmen from town to the plantation and return. The general dimensions of the launch are: Length over all, 32 feet; beam, 9 feet; draft, 1 foot 6 inches; speed, 9 to 10 miles per hour. The launch is an open boat with large cockpits, both forward and aft, with seats on each side for carrying the workmen. The machinery, located amidships, consists of two three-cylinder, four-cycle 4½-inch bore by 5-inch stroke Speedway marine gasoline (petrol) engines of 18 horsepower each, enclosed under sliding hatches and arranged for control by the engineer.

Chinese River Boats

Four river boats for passenger, light cargo and mail service were built recently at Hongkong, China, by Chinese builders. Three of the boats are 66 feet long, 13 feet 6 inches beam and 3 feet 6 inches molded depth, equipped with four-cylinder, four-cycle, 60-brake horsepower kerosene (paraffin) Djinn engines, manufactured by Messrs. Brazil, Straker & Company, Ltd., Vulcan Iron Works, Bristol. Each of these vessels



MOTOR BOAT BUILT IN CHINA FOR RIVER WORK

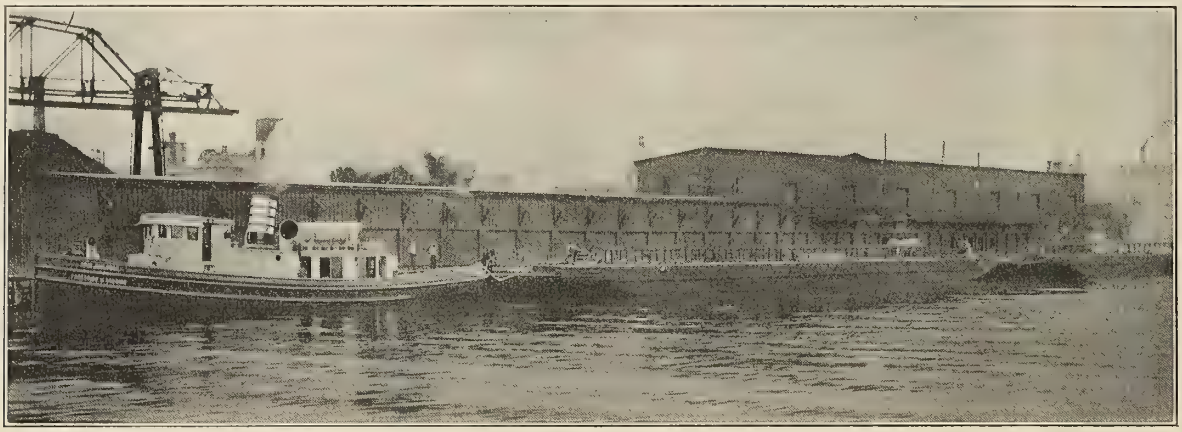
maintained a speed of 8¾ knots on the official trial run from Hongkong to Wuchow, a distance of 250 miles. The fourth vessel is a larger boat, having a length of 86 feet, but the beam and molded depth are the same as in the others. This boat, however, is equipped with a six-cylinder, 160-brake horsepower Djinn engine, which enabled her to maintain a speed of 10¼ knots on the trial run from Hongkong to Wuchow. On this boat an auxiliary engine drives a dynamo for electric light, including a 19-inch searchlight, and the service pumps.

The engines and all accessories for these boats were built to the order and under the personal supervision of Messrs. R. Wilson & Sons, of Laygate Circus, South Shields, with a special view to the service for which they were intended.

Steel Tug Frederick U. Robbins and Car Floats for the Erie Railway Service

When President Underwood, of the Erie Railroad, was asked recently where the new tug *Frederick U. Robbins,* under construction by the Manitowoc Ship Building & Dry Dock Company, of Manitowoc, Wis., would go into commission, he replied: "We are going to use the Chicago River for a railroad yard and the new tug will be used for towing the car floats there."

Two car floats are now in the Erie service in Chicago which were also built by the Manitowoc Ship Building & Dry Dock Company. They are 175 feet long, 32 feet wide and 8 feet deep, fitted with double tracks and carry eight cars each. A trucking platform is located between the two tracks and is on a level with car floors, enabling any or all of the cars to be unloaded. The cars are loaded at a central slip and towed to the various warehouses or boat docks that have no railway connections, and here unloaded. These floats are sheathed above the waterline with nine inches of fir and oak, and are built for hard usage and of exceptionally heavy construction, having a longitudinal girder under each track. The floats are subdivided into nine compartments by watertight bulkheads.



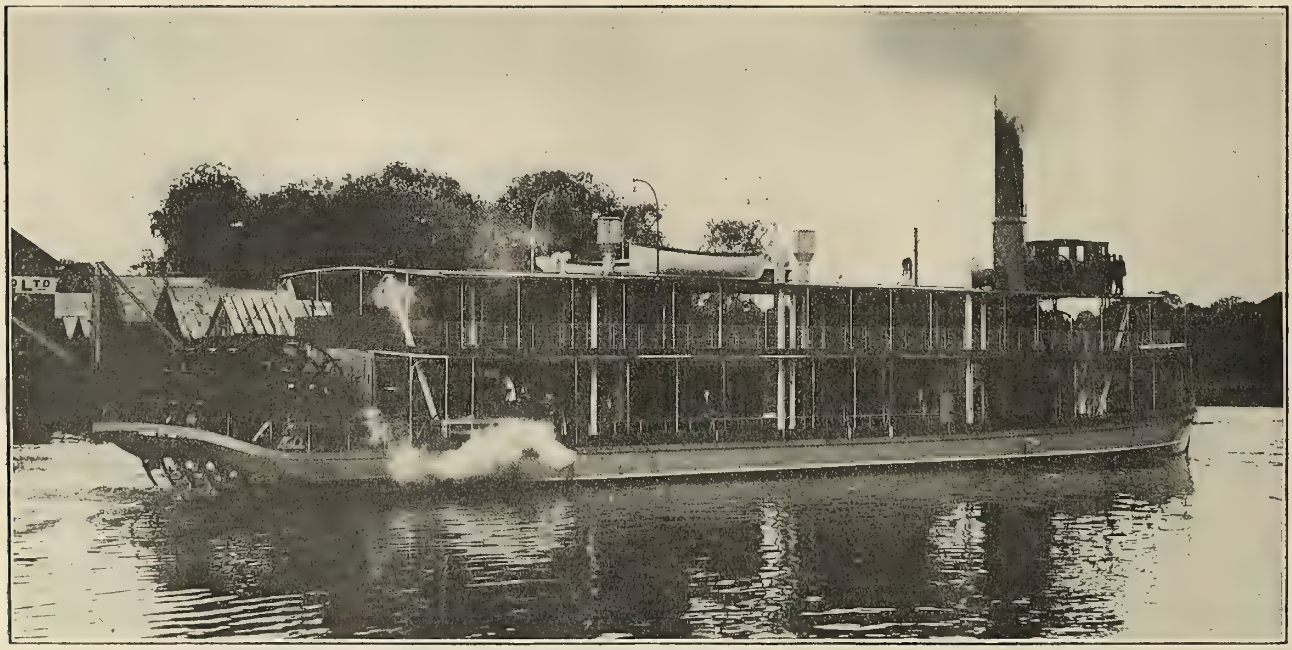
NEW ERIE TUG AND CAR FLOATS FOR SERVICE ON CHICAGO RIVER

The new tug is of steel construction throughout and is 87 feet long overall, 22 feet beam and 13 feet depth. She is constructed for year round service and the waterline strake throughout and all bow plating have been doubled for ice work. Steam is furnished at 130 pounds pressure by a firebox marine boiler 10 feet 6 inches diameter by 14 feet long. Propulsion is by an 18-38 by 30-inch condensing engine with attached air pumps, feed pump, bilge and cooler pump. To comply with the smoke ordinance of the city of Chicago, the *Robbins* has been equipped to burn hard coal. Forced draft is furnished by a Sirocco fan driven by a Terry turbine.

Of up-to-date construction in every way, this powerful tug has a steel deck house and pilot house, steam steering gear and an electric plant. Sleeping quarters are provided aft for eight men with galley and mess in the hold forward.

Stern Wheel Steamer for the Congo

A number of large stern-wheel steamers have been built recently by Lobnitz & Company, Ltd., Renfrew, for service on the River Congo. Most of these vessels are of a very similar type, the dimensions varying but little. During the last year three such vessels were shipped to the Congo, one of which is illustrated. With a hull 171 feet long between perpendiculars, 30 feet breadth molded and 7 feet depth molded, the boat is of ample size for freight and passenger service. Propulsion is by



ENGLISH-BUILT STERN WHEELER ON THE CONGO RIVER a stern-wheel, driven by compound surface condensing engines, with cylinders 21 and 42 inches diameter by 54 inches stroke. Steam is supplied at 130 pounds working pressure by two boilers of the locomotive type, fitted with a forced draft inclosed ash-pit system to enable the burning of wood as fuel, or the boilers can be arranged for burning oil fuel on the pressure system. The main auxiliaries include an independent surface condensing plant fitted with Weir's air and feed pumps and a centrifugal circulating pump.

Large Motor-Driven Ferry, Bridgit

In considering the construction of a ferryboat to be used in connection with the new line of the Oakland, Antioch & Eastern Railway from Sacramento to San Francisco, Cal., it was decided that a gas engine installation would meet the requirements of this service far more economically than steam engines, and, consequently, the new ferryboat, *Bridgit,* was equipped with a 500 horsepower unit built by the Union Gas Engine Company, of San Francisco.

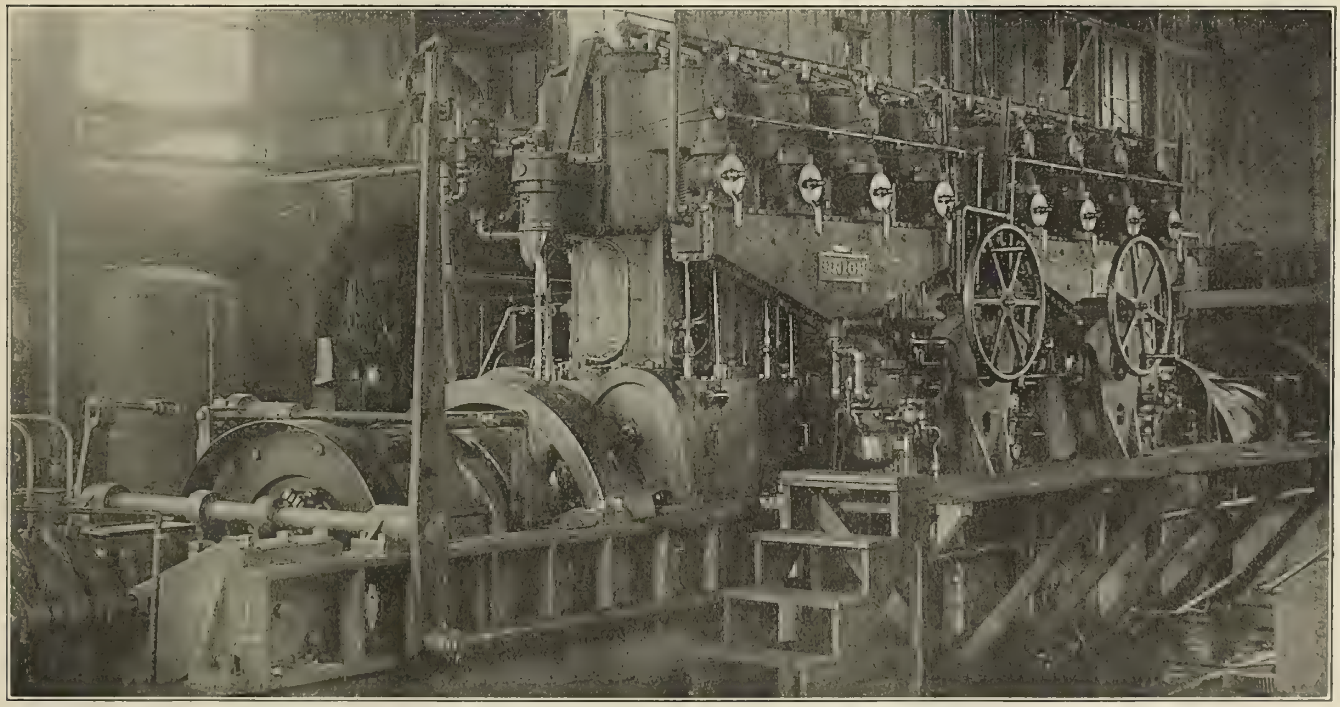
This vessel makes sixteen regular trips every day, carrying passenger and freight trains weighing from 350 to 400 tons. Her overall length is 186 feet, and her beam is 57 feet, providing space for three tracks on the deck, each track being of sufficient length for three cars. The hull is of wood and is reinforced by longitudinal trusses in order to secure rigidity.

The propelling engine is of especial interest, as it is said to be the largest marine distillate engine ever built. It is an 8-cylinder, 500 horsepower unit, weighing approximately 90,000 pounds, and is more than 40 feet long. It is known as the open crosshead type of engine, that has been so successfully developed by the Union Gas Engine Company. The cylinders are exceptionally long, the lower ends being open on either side and serving as crosshead guides characteristic of steam installations. The engine is placed in the center of the vessel, being connected through disk clutches to propellers at either end. The wheels are of opposite pitch, and reversing is accomplished by whichever propeller is at the forward end of the vessel, as the vessel is double-ended.

In addition to the main engine, there is a 40 horsepower electric lighting and pumping engine and an 8 horsepower pumping engine. A 500-volt generator is used in the lighting set, in order to supply current for lighting the cars; the vessel's lights are also supplied from the same source.

MOTOR RAILWAY FERRY BRIDGIT

A pneumatic steering-gear is provided, and, in addition, there is a hand-controlled gear that may be used in emergency. The operation of this vessel has been watched with considerable interest, as the engine room crew consists of only one man, a fact which gives an idea of the ease of handling and the reliability of this type of engine.



500-HORSEPOWER OPEN CROSSHEAD UNION ENGINE FOR FERRYBOAT BRIDGIT, ERECTED IN BUILDERS' SHOP

Correction.—In the article on "Bearing Pressure on Guide of Paddle Engines," published on page 401 of our September issue, the words "in tension" in the top line of the second column should read "in compression."

American Steamers on the Magdalena River

The Magdalena River, in the Republic of Colombia, South America, is very much like the Missouri River, in the United States, except that the latter has a length of 3,000 miles while the distance from the mouth of the Magdalena to the rapids at Honda is only 600 miles. Navigation on the lower river for 30 miles below Honda is through rapids similar to those in the upper Missouri River between the mouth of the Mussel Shell River and Fort Benton. These rapids also have the same characteristics as those in the Alleghany River, but the rapids at Honda, which are one mile long, are far more turbulent, resembling the rapids below Niagara Falls. Light-draft steamers are able to go through these rapids without cargo during high water with the aid of two or three very large hawsers taken to the steam capstans, and above them the upper river can be navigated for 150 miles by vessels carrying from 80 to 100 tons of freight.

First American Steamers to Navigate the Magdalena

Navigation of the Magdalena River by stern-wheel steamboats of American build was begun soon after the close of the Civil War, in 1865. Previous to this date the river was navigated by large side-wheel boats built in the East and in Europe. The first stern-wheeler on the river was a composite boat built with iron frames and teak planking, which was designed by an American, but the draft of this boat proved too great for successful navigation.

Early in the seventies two Colombian steamboat captains visited America to examine the boats navigating the Western rivers. After inspecting the Ohio River steamboats and finding them suitable for navigating the Magdalena River, contracts were made for the construction at Pittsburg and Cincinnati of eight wood stern-wheel boats, four of which were named the *Isabelle, Barranquilla, Murillo* and *Colombia.* These boats were sent out under their own steam, coasting from New Orleans to the coast of Florida, thence to Cuba, Haiti and Jamaica, and from these islands, when the weather permitted a safe crossing, across the Caribbean Sea. This was continued until about 1874, when one of the boats built at Cincinnati was caught in a storm after leaving the mouth of the Mississippi River and was lost with all on board.

Wooden Hulls Found Too Costly

After the loss of this vessel, the companies operating steamers on the Magdalena River resorted to the scheme of having the wooden frames worked out in the United States and then the boats were erected in Colombia under the direction of a few skilled mechanics brought down from America. It was found, however, that the life of a wood-hull steamer in the tropics did not exceed five years without entirely rebuilding the hull, and, as this was done at a price which usually exceeded the original cost of the hull, attention was directed to the building of steel-hull steamers with watertight compartments, a type of vessel which proved successful and was universally adopted by all the steamboat companies.

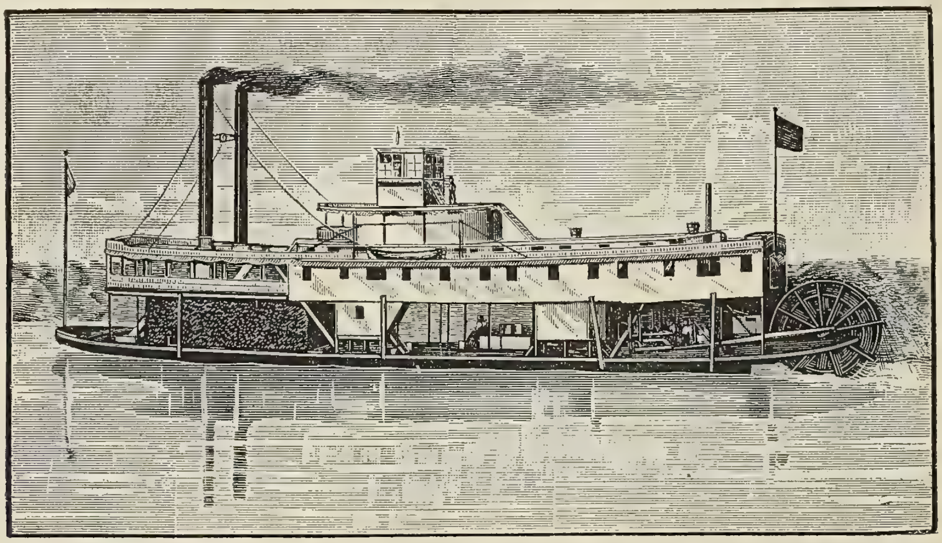


FIG. 1.—STEEL STERN WHEEL STEAMER FRANCISCO MONTOYA, BUILT BY JAMES REES & SONS COMPANY, PITTSBURG, PA., IN 1878, FOR SERVICE ON THE MAGDALENA RIVER

The First Steel Stern Wheel Steamer

The first steel stern-wheel steamer to successfully navigate the Magdalena River was the *Francisco Montoya,* built by James Rees & Sons Company, Pittsburg, Pa., in 1878. This, by the way, was the first steel-hull river steamer constructed in America. She was 150 feet long, 29 feet 6 inches beam, with a depth of hold of 4 feet. The draft, with 75 tons of fuel on board, was 26 inches. Steam was supplied by two tubular type boilers, 45 inches diameter and 17 feet long, to two high-pressure engines 15 inches diameter and 5 feet stroke, fitted with Rees adjustable or variable cut-off. The design and plans for this type of river steamer were perfected in 1875, but, owing to the opposition that existed against the use of steel hulls on rivers having a rocky bed, the vessel was not built until three years later. In fact, at that time rumors were published to the effect that the constructor of such a boat was a fit subject for a lunatic asylum, as it was contended that if a steel-hull boat struck a bank or a sand bar in the river the boat would fall asunder or break to pieces like a watch spring. However, the superintending engineer of the steamboat company was finally sent to inspect the material, which was crucible homogeneous steel of from 70,000 to 85,000 pounds tensile strength, costing 7 cents per pound. Test pieces from the plate were heated cherry red and dipped in cold water and also case-hardened. In fact, almost every conceivable test was made, and it was found that every piece turned over flat on itself without a

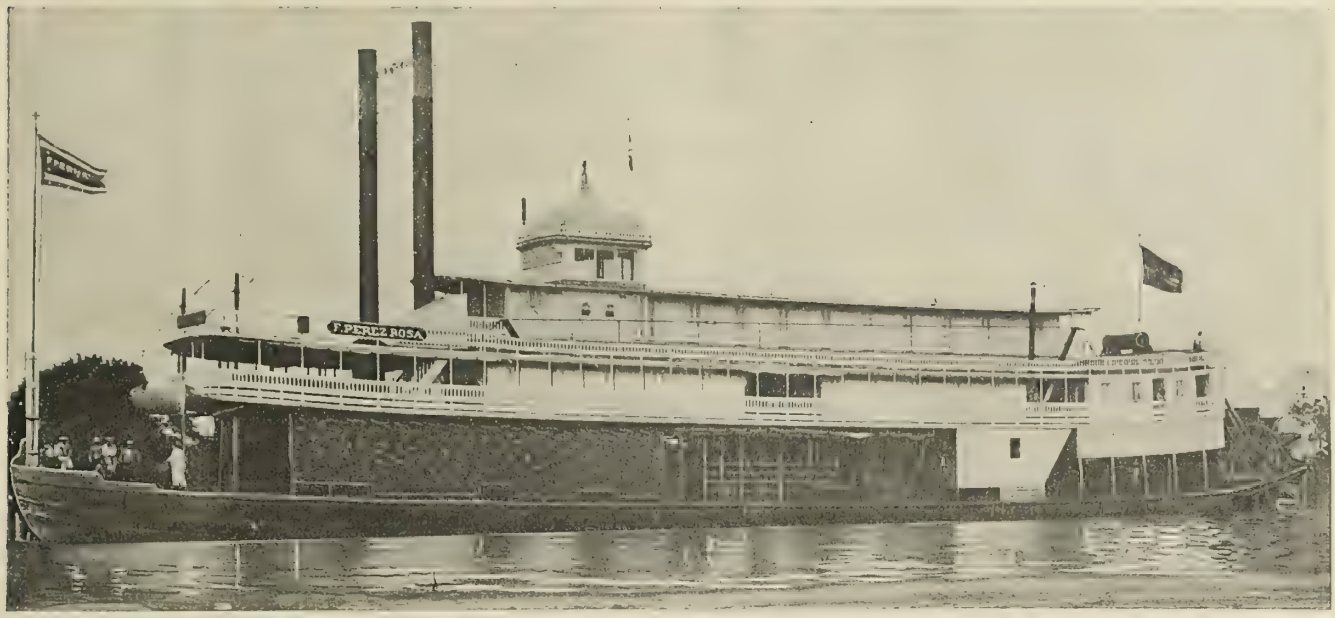


FIG. 2.—STEAMER F. PEREZ ROSA, A TYPICAL MODERN AMERICAN-BUILT RIVER STEAMER ON THE MAGDALENA RIVER. LENGTH, 170 FEET; BEAM, 33 FEET; DEPTH OF HOLD, 4 FEET 6 INCHES. CAPACITY, 450 TONS; SPEED, 15 MILES PER HOUR IN DEAD WATER

fracture. The material was finally accepted, and, in his report, the engineer stated that it was the finest material he ever saw for plating a steam vessel.

The keel was laid in Barranquilla on Nov. 26, 1878, and in exactly two months steam was raised on the boat, and on Feb. 13, 1879, she started up the river on her maiden trip with 75 tons of freight and five hours' fuel on board, drawing 26 inches of water. Although the water was low, the maiden trip was made within three hours of the running time of the fastest trip ever made on the river. Captain T. M. Rees, general manager of the Rees firm (constructors of the vessel), personally supervised the erection of the vessel, and also its opration on its trial trip.

The boat had twenty-one watertight comparcments. The longitudinal bulkheads were secured to the keel and bottom of the boat and floor frames by steel-flanged intercostals which were patented by James Rees. The thickness of the steel plate and framing was based on the construction of the Alleghany River packet boats, 1/16-inch thickness of steel plate being used for every 1-inch thickness of No. 1 white oak used in the wood hulls. This practice, it has been found even to the present day, insures a boat as strong, if not stronger, than a similar boat built of wood.

Present Types of Vessels on the Magdalena

Almost as many types of steam vessels have been tried out on the Magdalena River as have been tried in America. Vessels built of good yellow pine, Spanish cedar, teak, iron and steel, and boats with side wheels, recess wheels, screw propellers, and half submerged twin screw propeller boats with wheels and "walking sticks" to propel them over bars, have been built, but none of these vessels has seemed to fulfill all of the requirements as well as the light-draft steel boats with longitudinal and athwartship bulkheads forming from twelve to twenty-five watertight compartments. To prolong the life of such vessels, the hull plate is usually galvanized and all seams are double riveted, mainly with cold rivets. The thickness of the plate runs from No. 12 to No. 6 gage, all

FIG. 3.—MAIN CABIN ON SALOON DECK OF STEAMER F. PEREZ ROSA

being of the best open-hearth steel of from 60,000 to 65,000 pounds tensile strength, in accordance with the size of boat, which ranges from 100 to 500 tons capacity.

The large boats built by the Rees firm now navigating the Magdalena River are 170 feet long, 33 feet beam and 4 feet 6 inches depth of hold, carrying 90 tons of freight on 28 inches draft at a speed in dead water of 15 miles per hour. Power in the large boats runs from 300 to 400 horsepower, and, when there is plenty of freight on the river, the large boats take from 1 to 4 light-draft steel barges in tow, carrying from 50 to 75 tons of freight in each barge. Figs. 2 and 3 show views of the latest of these boats, which was completed in 1911. The total tonnage capacity of the boat is 450 tons and her dimensions are the same as mentioned above. Steam is supplied by three tubular boilers, 48 inches diameter and 15 feet long, to high-pressure engines, 15 inches diameter by 6 feet stroke, fitted with a Rees adjustable or variable cut-off. What is practically a duplicate of this vessel is now under construction by the Rees firm in Pittsburg for the same company, except that the new vessel will have increased engine power and larger passenger accommodations.

Comments by an American Engineer

Some interesting comments on steamboating on the Magdalena River were made recently by Captain B. L. Wooster, a mechanical engineer who has been in South America for over twenty years supervising the erection and operation of many of the stern-wheel boats built in the United States. He says: "At present there are no wooden-hull steamboats or barges on the Magdalena River; they are all of galvanized steel. The steamers are stern-wheel boats and were built in Germany, England and the United States. There is no doubt that the steel hull, if properly constructed, is far superior to either wood or composite construction for this service.

"During the low stages of water, the Magdalena River consists of a series of deep pools separated by sand-bars, over which there are at times not more than 3½ feet of water, and it is a frequent occurrence to find several boats tied up below these bars waiting for a Rees boat to come along, as these boats invariably hit these bars at full speed, stop the engines, and when the following wave runs up start up again and dig their way over the bar, making a channel through which the other boats follow. This channel soon fills up and has to be opened up again by the next boat up or down the river.

"During the revolution of 1899-1901 one of the Rees boats, the *Helena,* was captured by the rebels, who converted her into a gunboat by installing several guns and piling sacks of salt along the sides for breastworks.

"During a night engagement on the river between the rebels and the Government fleet, the *Helena* by mistake rammed at full speed a heavy steel dredge belonging to their own fleet in an attempt to ram the Government gunboat *Hercules.* The dredge was cut almost completely in two and sank immediately, and the *Helena,* coming under fire from the entire Government fleet, had all her upper works riddled and about everyone on board either killed or wounded. The vessel drifted alongside the *Barranquilla* and was captured. The heavy wrought iron stem and the bow plating of the boat were twisted into a knot but not broken; the forward collision bulkhead held and the boat did not leak a drop. She was towed down the river and lay at Barranquilla for at least a year before the company got her back from the Government. When she was taken over for repairs she was still dry and the bones of two men were found in the hold, where they had probably crawled after being wounded and had been overlooked by the Government troops when they took the boat.

"Many boats which the writer has erected in Colombia and in Brazil on the Amazon were put together by native labor, and as a rule the natives proved very good workmen. The boats are operated entirely by natives, and, in spite of the fact that they were previously unfamiliar with the machinery, they handled them very well."

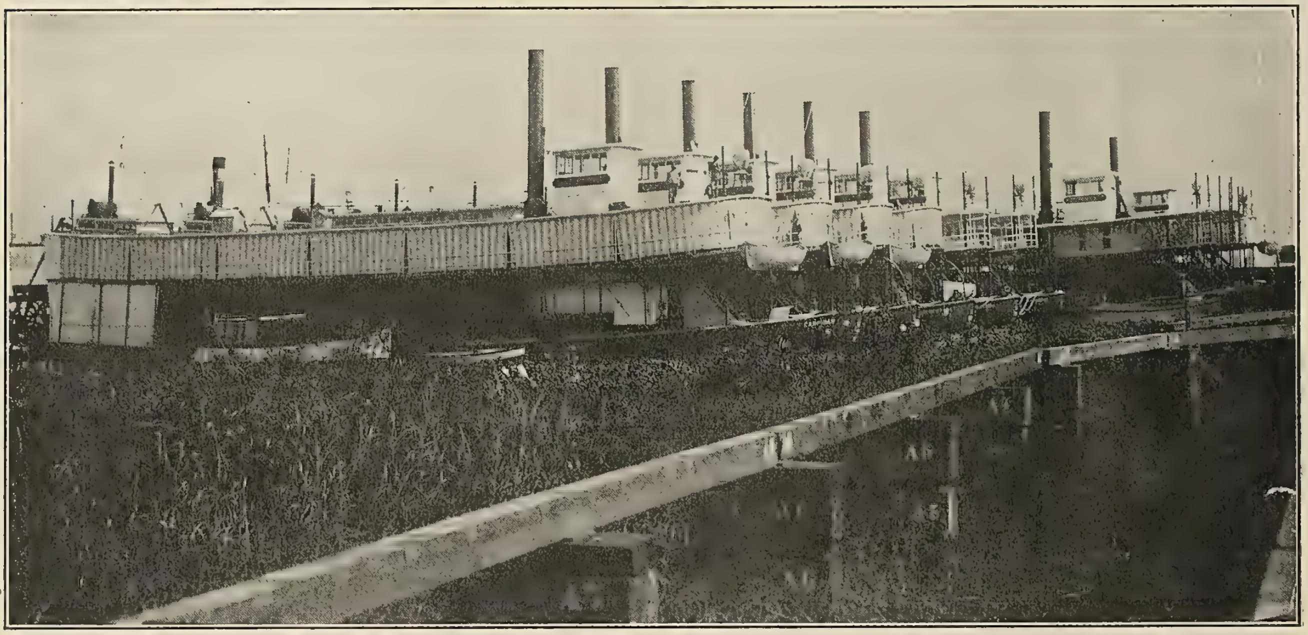


Fig. 4.—Fleet of 14 Rees Stern Wheel Steamers Assembled at Para, Brazil, in 1912

Zulia River Opened to Navigation by a Rees Boat

A sequel to the success made by the Rees firm with the construction of the *Francis Montoya* on the Magdalena River is found in the design for a boat which they have built for operation on the Zulia River in Colombia. In 1880 the steel stern-wheel steamer *Venezuela,* designed to carry 60 tons of freight on 10 inches draft at a speed of 8 miles per hour, with a steam pressure of 120 pounds per square inch, was built. When completed, the mean draft of the boat was 9 inches, and on her maiden trip a speed of 8 miles per hour was made with 75 pounds of steam. As in the case of the *Francisco Montoya,* this boat was also erected and taken out on her maiden trip under the personal supervision of Capt. T. M. Rees, general manager of the Rees Company, and it can be truthfully said that the Zulia River was opened up to navigation by this firm.

Stern Recess Wheel Steamer Osceola

The steamer *Osceola*, under construction by the Merrill-Stevens Company, of Jacksonville, Fla., for the Clyde Steamship Company, is now nearing completion. It is a light-draft, stern-wheel steamer fitted for freight and passenger service on Florida rivers, and is of the following dimensions:

	Feet
Length over all	188
Length between perpendiculars	180
Molded depth at bow	12
amidships	8
at the stern	10
Load draft	5

The steamer is designed for an economical working speed of 12 miles per hour.

As will be seen in Fig. 1, the vessel has a straight stem, but owing to the stern wheel it has a double stern, one on each side of the wheel, leaving room on the sides for the main bearings, crank and connecting rods and a walk for the oiler, thus allowing ready access to these vital parts, as is all clearly shown in Figs. 2 and 3. These illustrations also show the construction at the wheel case, where the bottom is so formed as to guide the water to the wheel with the least possible chance for losses due to eddies and other hydraulic resistances. It should also be noted that the form given to the hull at the intersection with the wheel casing also has the effect that at a speed of 6 miles per hour and over the water will keep a uniform level at the point where the wheel buckets enter the water, which level is approximately at the angle where the bottom meets the wheel casing. This is a very important point, not only because it largely diminishes any tendency to vibration, but it also makes the action of the wheel on entering the water entirely independent of loading and of speed, and materially increases the efficiency of the propelling power.

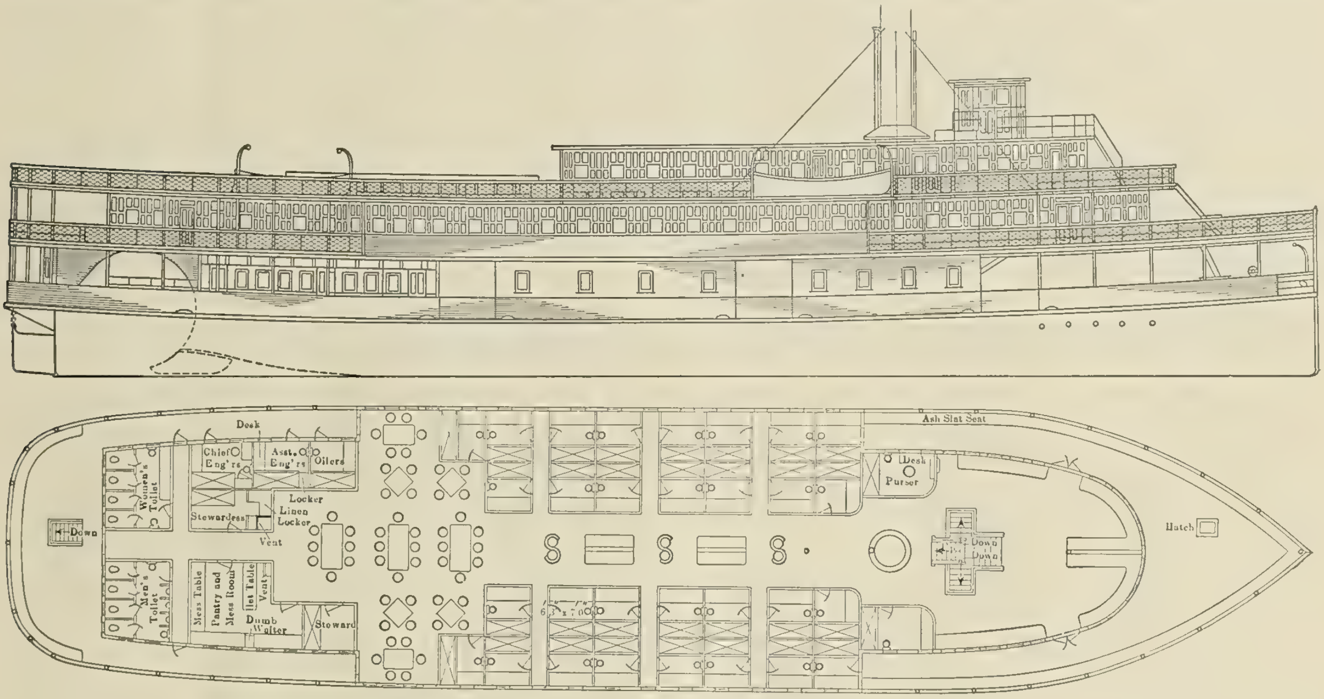


FIG. 1.—PROFILE OF THE OSCEOLA AND PLAN OF SALOON DECK

Wheel

The wheel, as can be seen in Figs. 2 and 3, is of the herring-bone type, allowing the buckets to enter the water gradually and without the splash and resulting vibration to the ship which would be the case with a wheel with straight buckets. It is strongly built of rolled steel bars on cast steel hubs, while the brackets that connect the buckets with the arms are also steel castings. The shaft is unusually heavy, and with the cross bracing all deflection of the shaft is absolutely avoided. Varying from the usual custom, the steel hubs are shrunk on and strongly keyed onto the round shaft.

Rudders

With a stern-wheel steamer, and especially with a wheel of the recess type, the proper arrangement of the rudders is of paramount importance to secure good steering qualities. The system of rudders as adopted on this boat combines the steering qualities obtained by the arrangement common with overhung wheels and the arrangement common with recessed stern wheels, giving the steering action from the wheel water both going ahead and backing independent of the headway. All the four rudders are connected to one Williamson combined hand and steam steering engine, which is operated through shafting and bevel gears from the wheel in the pilot house.

Hull Construction

As this is a very shallow hull compared to its length, and as the hull is necessarily so shaped that the side plating does not give any longitudinal stiffness, there are three heavy longitudinal girders running practically the full length of the boat. Of these the two outside ones are regular lattice girders, made up of heavy top and bottom chords connected by angle lattice bracing between, while the center one is a combination plate and lattice girder stiffened by heavy top and bottom angle chords, with angle bracing on both sides arranged similarly to the two lattice girders. This center girder also forms a bulkhead running the full length from the collision bulkhead at frame 5 to the wheel casing, and is broken only by two small door openings, one in the boiler room and one in the engine room, which are reinforced by heavy steel angles. To further assist in stiffening the hull, the different lengths forming the steel plate keel are welded together. Each floor frame is built up in the usual manner as Z girders, while there are four transverse bulkheads, thus dividing the hull into nine compartments. Those compartments forming the forecastle are fitted up as quarters for the crew.

A Providence deck steam capstan is placed forward.

The main deck beams are made of steel angles, one to each frame, and are tied to the frames by large gusset plates strongly riveted, and also supported by the longitudinal girders and angle stanchions. The 2½-inch Oregon pine deck

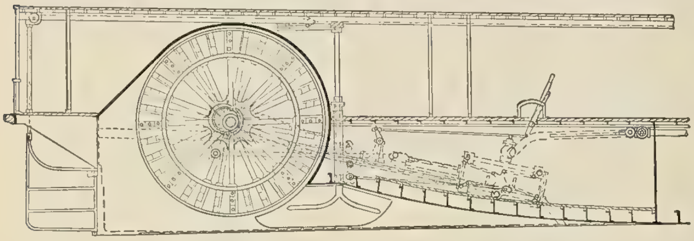


FIG. 2.—FORE AND AFT SECTION OF ENGINE ROOM

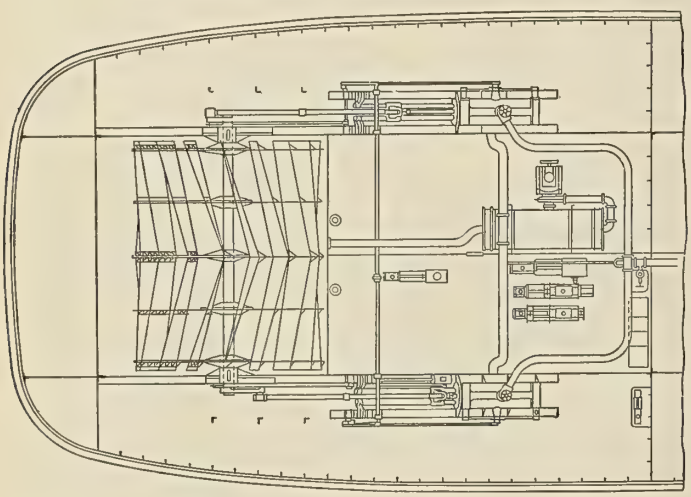


FIG. 3.—PLAN OF ENGINE ROOM

is protected from wear in handling the cargo by a sheathing of yellow pine.

This system of longitudinal girders and frames forms an unusually stiff hull free from deflection due to uneven loading.

Machinery

There are two 24-inch by 72-inch single-cylinder reversible condensing engines of the Corliss valve type, one on each side of the ship and connected direct to the wheel shaft, the cranks forming an angle of 90 degrees. These engines were built by the Merrill-Stevens Company, and designed to suit this purpose, and to give the best efficiency at the normal working load of 600 horsepower, while a maximum power of over 1,000 horsepower may be obtained. Each engine is mounted on two heavy angle and plate frames, which also carry the main bearings, and are strongly riveted to the frames and girders forming the hull.

There are two boilers of the Scotch type, with corrugated furnaces, and they are placed well forward so as to balance the weight of the engines. They are fitted to burn either coal or wood. Over the boilers, and built inside the breeching, is a Foster superheater large enough to give 100 degrees superheat with 120 pounds pressure.

The engineer's stand is over the starboard engine, from which he operates a reverse engine of the steam ram type. He may also reverse the engines directly by hand, and within easy reach is the throttle stand.

In the compartments between the engines are located the condenser, with a centrifugal circulating pump, a feed-water heater, hot-well, air pump, and all the different pumps for boiler feed, bilge pump, general service and fire service. In the selection of the power and steam plant nothing has been spared to secure high efficiency with least possible weight, and to cut down the consumption of fuel to a minimum.

The different compartments of the hold and the engine room and the galley on the main deck are all supplied with ventilators, the two last ones terminating above the hurricane deck.

General Arrangement

On the main deck are compartments for the galley, white and colored deck passengers, and an enclosure for the boilers and superheaters. The balance of this deck is reserved for the cargo.

Above the main deck are the saloon, hurricane and texas decks, above which is placed the pilot-house with a bridge extending out to the sides of the ship.

As the owners desired a very light boat of low load draft, the superstructure was built as light as is consistent with strength. The carlins are run in one continuous length the full width of the deck, and where they are not supported by bulkheads and partitions they rest on intermediate strong-backs, on a system of headers and columns. These decks and the pilot-house are held down by the rods along the sides concealed in the walls.

On the saloon deck, as shown in Fig. 1, is the social hall forward, up to which leads the stairway from the main deck, while above this is the stairway to the texas. This main stairway may be entered from either side of the main deck, from which it is separated by double doors and paneled partitions conforming to the general finish above. Hand-rails, balusters and newel posts of both these stairways are of polished mahogany, handsomely molded.

Next to the stairway on the port side is the purser's room, while amidships are thirty-one staterooms for first class passengers, each with two berths, washstands and upholstered settees. Aft of these is the dining room, with a seating capacity of fifty persons, while aft of this is the pantry, connected by a dumbwaiter with the galley below, and quarters for the steward, stewardess, engineers and oilers; all of them fitted with washstands and lockers. Furthest aft are the toilets for men and women passengers.

In the texas is the captain's room, located forward, with the windows so placed that he has a full view all around. Next to this is the smoking-room, provided with upholstered seats, quarters for the mates and the pilots, and eight staterooms for passengers fitted up the same as the staterooms on the saloon deck. It will be seen that this gives stateroom accommodation for seventy-eight first class passengers. On the hurricane deck is also placed the regulation lifeboats, handled by the usual davits.

Both of these decks are provided with slatted seats along the outside railings for the accommodation of the passengers, while outside-stairs give the crew access to the decks and the pilot house without interfering with the comfort of the passengers.

The inside walls in the social room, dining and smoking rooms, passageways and around the smokestack are finished in panels broken by fluted pilasters at the corners and intermediate pilasters at the walls, where two staterooms are built together, all painted white enamel.

Ventilation and Light

All of the staterooms are well ventilated by perforated panels below and by a row of grillwork worked into the molding overhead, while the inside staterooms on the saloon deck are lighted, and get additional ventilation from a row of fanlights placed under the seats in the texas. These fanlights are of ribbed glass, giving privacy in the staterooms, and they are so hinged that when opened they still obstruct the view from the outside. It is worthy of mention that all the windows are extra large, balanced by Pullman spring sash balances, and they may be opened to a height that is unusual aboard ships. Each window is provided with blinds that can also be raised out of view. The doors to the officers' rooms are provided with blinds inside of the paneled door.

The dining room gets additional light and ventilation from a monitor above, with windows swinging out, and while open they are protected by the overhanging roof. This monitor is also finished in white panel work, while the ceiling is supported by a system of ribs between the windows, and the intersections of these ribs are supported by fluted columns conforming to the general finish on this deck.

Light is furnished by a 10-kilowatt "Spiro" turbine generator. There are single lamps in all the staterooms and in the passageways, while in the social hall are five dome lights, and similar dome lights in the dining-room and smoking-room. Besides these there are Pullman berth reading lights over the seats along the walls in the social hall and the smoking-room. On top of the pilot-house is a powerful searchlight controlled from inside the pilot-house.

The hull, boilers and machinery of the *Osceola* were designed by Mr. Stevens, president and naval architect of the Merrill-Stevens Company.

Seamless Steel Shallow Draft Motor Launches

The Seamless Steel Boat Company, Ltd., Wakefield, has built a number of different types of shallow-draft motor launches for service on the rivers in South America, Egypt

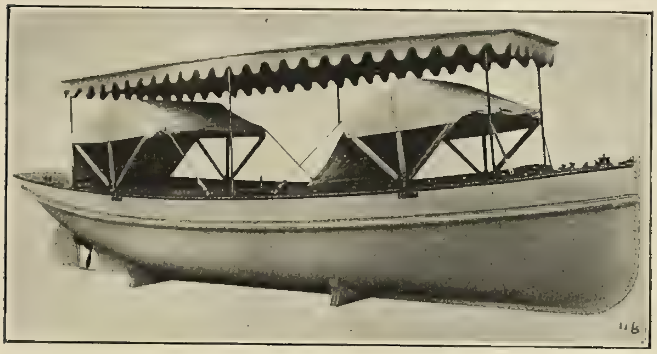


FIG. 1

and India. These boats are built for commercial and general purposes, and range from 20 to 35 feet length and from 7 to 11 miles per hour speed. None draws over 2 feet of water, and the draft in most of them is limited to 18 inches. The

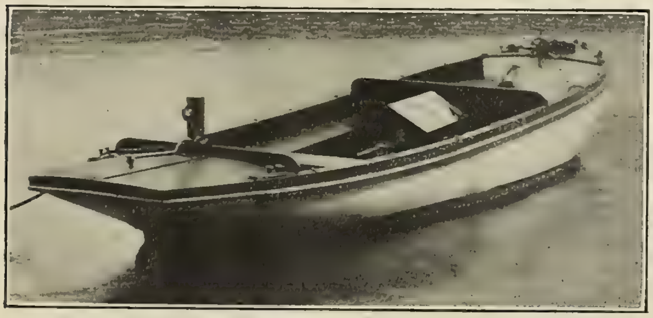


FIG. 2

simplicity of construction and completeness of equipment can be seen from the illustrations.

Fig. 1 is a motor launch 25 feet long, 6 feet 3 inches beam and 3 feet depth, supplied to a petroleum company for use in Egypt. Her hull has a graceful counter stern and is fitted with a canvas awning and folding canvas storm hoods, both forward and aft. The engine is a two-cylinder, 15-horsepower kerosene (paraffin) motor, which drives the boat at a speed of from 9 to 10 miles per hour on a draft of 1 foot 9 inches.

In Fig. 2 is shown a 30-foot launch which has a beam of 7 feet and a depth of 3 feet 6 inches, built for towing purposes in Brazil. The draft is 2 feet and the boat is propelled by a four-cylinder, 28-horsepower gasolene (petrol) engine at a speed of 10 miles per hour.

Oil-Engined Ferryboat

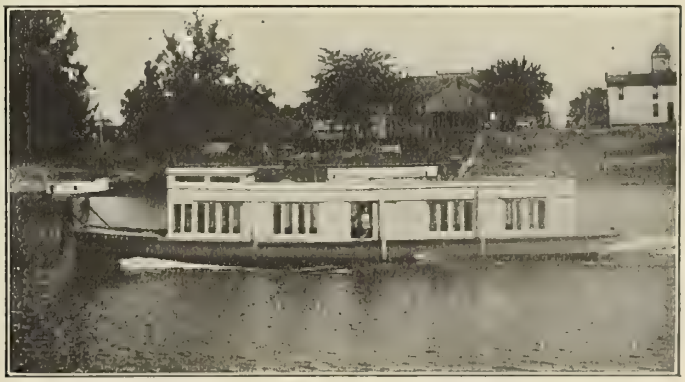
A well-modeled ferryboat, named the *Evelyn*, 80 feet long over all, 20 feet beam and 3 feet 6 inches draft, was built this season by A. Hansen, Brooklyn, N. Y., for the Ocean Beach Fire Island Company, Bayshore, L. I. She is built of wood throughout, with oak frames and yellow pine planking 2 inches thick. The keel and keelson are both 8 by 10 inches. Pro-

80-FOOT MOTOR FERRYBOAT EVELYN

pulsion is by twin screws, driven by two kerosene (paraffin) oil engines of 50 horsepower each, supplied by August Mietz, New York City. The boat's regular run from Bayshore, L. I., to Fire Island, is accomplished in 40 minutes, which is equivalent to a speed of 12 miles per hour. There is an upper deck above the main deck and a large cabin aft on the main deck, giving ample capacity for 250 passengers.

Passenger and Mail River Boat

The illustration shows a motor boat 44 feet long, 6 feet beam, drawing about 20 inches of water, propelled by a Standard gasolene (petrol) engine at a speed of a little over 10 miles per hour. This boat is operated on the Ohio River at Cal-



SHALLOW DRAFT RIVER MOTOR BOAT DOING MAIL SERVICE

houn, Ky., for carrying passengers and mail, a service which requires absolute reliability from the motive power in order to make connections with railroad trains.

Development of Producer Gas Motor Boats

Only a few years ago a producer-gas motor boat was looked upon as a novelty. The early installations were in the nature of experiments, and while striking advantages from this form of propulsion seemed possible, nevertheless most marine engineers were skeptical as to the actual results which could be obtained in practical installations. Mistaken conceptions as to the type of engine needed for operation on producer gas, as well as to the proper methods of operating such a plant, were prevalent, and naturally led to failures. Certain of the engine builders, however, took a deep interest in the matter and have thoroughly investigated the possibilities of producer-gas power, with the result that many successful installations of internal-combustion engines and gas producers have been made, with very satisfactory results.

One of these companies, the Wolverine Motor Works, of Bridgeport, Conn., has now in service, both in America and on the rivers and canals in Europe, a great many producer gas installations. Among these is the 66-foot yacht *Liline* (Fig. 2), fitted with a 36-horsepower Wolverine motor using producer gas as fuel. This yacht has made many crossings from Dover to Ostend in the kind of sea that is characteristic of the English Channel, and she has also navigated that part of the River Rhine known as Binger Loch, which is one of the worst rapids in the river, and which only boats with reliable power are able to navigate. Work boats fitted with similar producer gas installations are also very much in evidence on the Continent, in France, Belgium, Holland and also in England. The tugboat seems to be a favorite field for this kind of propulsion, and the skippers who are using producer-gas boats declare that they could never be induced to go back to oil or steam, as with producer gas the boats are handled better and prove more reliable and economical than any others.

Fig. 3 shows the *Ville de Bruxelles,* which is a typical example of the producer-gas work boat, used regularly between Ghent and Brussels. The illustration shows the boat just after arrival from Brussels with a cargo of 180 tons. The

FIG. 1.—BELGIAN TUG WOLVERINE IV, 59 FEET 9 INCHES LONG, EQUIPPED WITH A 75-HORSEPOWER PRODUCER GAS PLANT

FIG. 2.—PRODUCER GAS YACHT LILINE

cargo was piled on deck to a height of at least 6 feet, and the vessel was drawing about 6 feet of water. A similar outfit, carrying 500 tons of coal, has lately been put into commission running from Belgium into Germany. It is fitted with a 75-horsepower producer plant and a 75-horsepower Wolverine engine. This boat has entered into a contract to carry coal from the German mines to different parts of Belgium for a period of five years in competition with steam power and the railways.

A French company is installing three 36-horsepower Wolverine engines with gas producers on boats which are the beginning of a fleet of no small dimensions which it is proposed to use in French canals, where the present means of locomotion are still very crude, horses being used, and, in some cases, man power, to tow the boats through the canals. Gasoline (petrol) engines cannot be used for this purpose except in very small units where the cost of fuel is unimportant, as in many places in France gasolene (petrol) is as high as 50 cents (2/1) a gallon, and of inferior quality.

A number of interesting producer-gas installations have been made by the Wolverine Motor Works in the United States, particularly on the rivers and in coastal work. One producer-gas installation made on a boat in Florida enabled the owners to carry a ton of freight 160 miles at a cost for fuel of only 3 cents (0/1½). Fig. 4 shows an 85-foot schooner fitted with a 75-horsepower Wolverine engine and producer, which is engaged in the menhadden fishing industry. On her first trip out this vessel brought back 125,000 pounds of fish, and the cost of fuel for the trip was equivalent to the use of gasolene (petrol) at 2 cents (0/1) a gallon. Other installations of a similar nature are doing good work in Delaware and North Carolina and further installations are being made.

Among the chief advantages claimed for producer-gas installations the most important, of course, is economy. The consumption of fuel on producer-gas boats has been reduced to a very low quantity as compared with the cost of operation of the same boat on oil. Careful records kept in this connection show that the cost for operating a 36-horsepower Wolverine engine on producer gas for twelve hours was 84 cents (3/6), as against $5 (1/0/10) formerly spent for heavy gasoline (petrol). In fact, the cost per horsepower-hour has been reduced to about one-fifth of a cent (0/0/1-10).

Another thing in favor of this class of power is the reduction in the crew required. On most of the boats mentioned in this article there is, of course, a skipper or captain who navigates the boat and controls the engines, and a boy about 14 years old, whose business it is to oil the engines and about once an hour put from 25 to 50 pounds of coal into the pro-

FIG. 4.—PRODUCER GAS MENHADDEN FISHING SCHOONER, M. M. MARKS

ducer, the plant requiring no other attention. While the boat is standing by and not in operation, the consumption of fuel is very small indeed. It is unnecessary to build a new fire if a small quantity of coal is consumed while the boat is not in operation. On an ordinary run, if the producer is properly

FIG. 3.—PRODUCER GAS FREIGHT BOAT VILLE DE BRUXELLES AT GHENT WITH CARGO OF 180 TONS

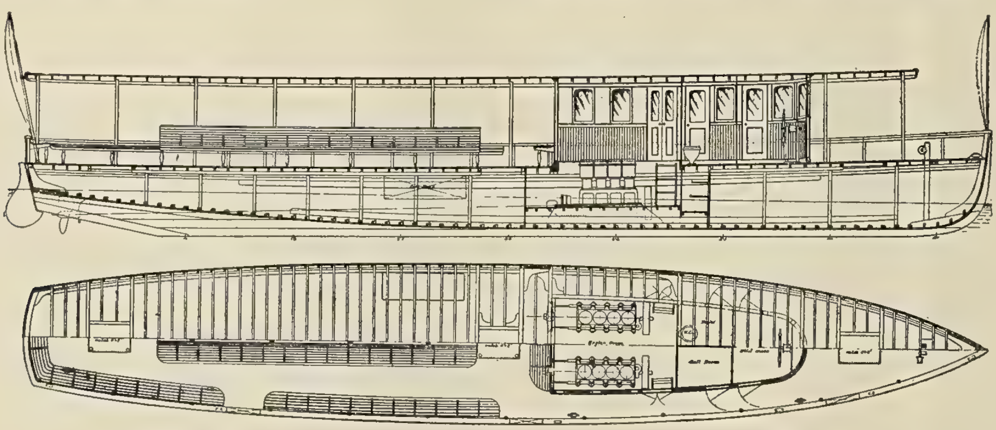
constructed, the only attention required, in addition to putting on small amounts of fuel, perhaps once an hour, is cleaning out the ashes once or, at most, twice a day. Then the producer can be closed up and left alone.

It is a great mistake to suppose that any kind of a producer and any kind of an engine will work successfully on board ship. A marine producer and a marine engine require flexibility (*i. e.,* slow speed, high speed and all intermediate speeds), while on shore, with the ordinary stationary type of producer-gas plant, power is usually absolutely steady, running throughout the day with a steady load. While the Wolverine Motor Company does not advocate the use of producer gas on boats requiring less than 36-horsepower, on account of the extra room required for the producer plant, as well as the added cost of the installation, the demand for larger units is steadily increasing, and the company is developing six-cylinder engines of 200 and 350 horsepower for operation with producer gas, a step which will tend to broaden the field for internal-combustion marine engines.

Passenger Boat for Cuban Waters to Operate on Alcohol Fuel

An interesting shallow-draft passenger motor boat, designed by Messrs. Cox & Stevens, New York, and constructed by William R. Osborn, Croton-on-Hudson, N. Y., has been built for passenger use in Cuban waters. The dimensions are: Length over all, 72 feet; beam, 12 feet; draft, loaded, 3 feet 6 inches.

The requirements presented to the designers were on the above approximate dimensions to produce a vessel that would have a seating capacity for seventy passengers and would carry the same on the draft given at a speed of 16 miles an hour in smooth water. To accomplish this result, it was necessary to reduce the weights as much as possible, and accordingly a light but substantial construction was adopted, the frames being of oak, most of them steamed, but a sufficient number being double-sawn frames, so as to produce the necessary rigidity of hull. The planking, bulwarks and main deck are of yellow pine, the fore-and-aft interior members are of Oregon pine in long lengths, and the awning deck of ½-inch tongue and groove white pine canvased.



SHALLOW DRAFT MOTOR BOAT TO BE RUN IN CUBAN WATERS ON ALCOHOL FUEL

The motive power consists of two 90-horsepower Craig motors, to be operated by alcohol instead of gasolene (petrol). These motors are located amidships, with an enclosing house arranged so as to afford ample ventilation. The fuel tanks are under the main deck aft, and are carefully designed to prevent all danger of leaks.

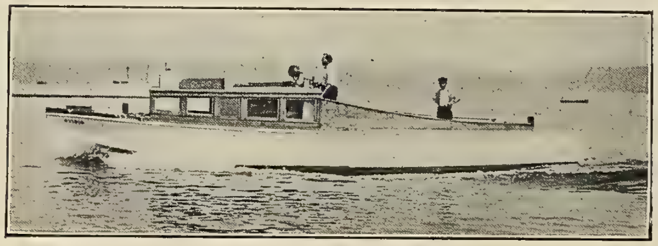
As the vessel was designed for day work only, no accommodations are provided, the house shown containing, in addition to the engine room enclosure, only the pilot house, toilet and mail room.

In preparing the lines for this craft, the designers adopted an easy running form, using the modified transom stern with an easy run, thus allowing a good flow of water to the propellers and a very clean entrance, associated with a considerable flare, so as to provide a dry boat when running in rough water. The rudder is overhung, and in order to make the boat hold her course well considerable deadwood is worked in between the propellers. This, however, is cut away aft, as shown, so as to make the vessel turn more easily.

The adoption of alcohol as fuel was made only after most thorough tests, and if the promised results are obtained it is more than likely that several other vessels of this same type, using alcohol as fuel, will be ordered.

A Work Boat for Mexican Waters

The Anglo-Mexican Petroleum Products Company has recently had built, from designs by Morris M. Whitaker, Nyack-on-Hudson, N. Y., two motor boats of fairly heavy construction, of the tunnel stern type, designed to carry a load of 2 tons in the cockpit on not over 20 inches draft. One of these



THE OVIDIO ON TRIAL

boats, named *Ovidio,* shown in the photograph, is now in service, and on a test obtained a speed of about 9¼ miles per hour in light condition. The photograph, which shows the boat under test, gives the boat the appearance of being slightly down by the head, due to the fact that she is light and the weight of her cargo in the cockpit is missing. The motive power consists of a four-cylinder, four-cycle Buffalo slow-speed motor, 5 inches by 6½ inches, turning a 26-inch three-blade Hyde propeller at a speed of about 450 revolutions per minute.

Each boat is 37 feet 6 inches long by 9 feet beam, and is equipped with a 100-gallon fuel tank and a 30-gallon fresh water tank. They are built in accordance with Government regulations, covering motor boats of the same class in the United States, with reference to fire extinguishers, lights, life preservers, etc., and are coppered for protection against the toredo. Due to the necessity of carrying so much weight on such light draft, the form is very full, which accounts for the big bow wave shown in the photograph. The forward sections are well flared for seaworthiness, and the bottom amidships is flat with rounded bilges. The tunnel is long and circular in shape.

The keel and framing are of the best white oak, with two pairs of longitudinal stringers of yellow pine and with yellow pine clamp and oak rubbing strake. The cabin outside and the cockpit coaming are of oak. The cockpit flooring is 18 inches above the waterline, well braced to carry the load and supplied with scuppers at each corner to make it self-draining. The motor, after starting, is controlled entirely from the steering station, and the exhaust, which is water-cooled by turning part of the circulating water into it, is carried out through the stern. All outside metal work under water is of bronze and on deck of galvanized iron.

This boat is designed for the use of the oil company in carrying package freight for their stations, and is fitted with a cabin and galley for passenger service.

Freight Handling Equipment at Kansas City Municipal Wharf

Due to the rapidly increasing river traffic on the Mississippi and Ohio rivers and their tributaries, the principal terminal cities are building wharfs and installing modern loading and unloading systems to accommodate this growing traffic. For some time now boats have been plying back and forth between the East and West, Pittsburg on the Ohio River and Kansas City on the Missouri River being the terminals. The cargoes consist of both package and bulk freight, and barges have been built especially for this traffic. These barges are constructed with hatches somewhat similar to those on the Great Lakes freighters. The barges are made up of compartments, each being fireproof, so in case of fire starting in any one compartment it will be confined to that compartment alone.

Kansas City has recently erected a municipal wharf, wharf house and machinery, which represent a thoroughly modern and complete equipment, as complete as found on any other river in the United States. One and one-quarter million dollars (£256,000) was subscribed by the citizens for its construction. The wharf is 50 feet wide by 525 feet long, constructed entirely of concreted timber, and supported on wooden piles driven to rock bottom. The concrete wharf house is adjoining, but is separate from the pier construction of the wharf, and is 40 feet wide and 305 feet long. It is supported on concrete walls which rest on wooden piles. An 8-foot gage track runs along the wharf; on which a 3-5 ton Brown hoist electric locomotive crane is operated.

3-TON BROWNHOIST ELECTRIC LOCOMOTIVE CRANE OPERATING ON WIDE GAGE TRACK ON THE MUNICIPAL WHARF AT KANSAS CITY, MO.

Two feed wires strung beneath the floor of the dock, one on each side of the track, furnish the current to the crane. The illustration shows the current being supplied by the "plug-in" system before the feed wires beneath the floor were used, but it shows the slots in the floor through which the trolleys on the crane reach the feed wires, beneath.

The crane is equipped with a 35-foot boom and has a capacity of 2 tons at the extreme radius. The crane hoists the freight through the hatches in the barges, and, making a half-circle turn, deposits its load at the door of the wharf house. Within the wharf house the freight is transferred to the various points by means of an electric telpherage.

If at any time it is desired to unload bulk freight, such as coal, sand, etc., the crane can be equipped with a grab bucket for this work.

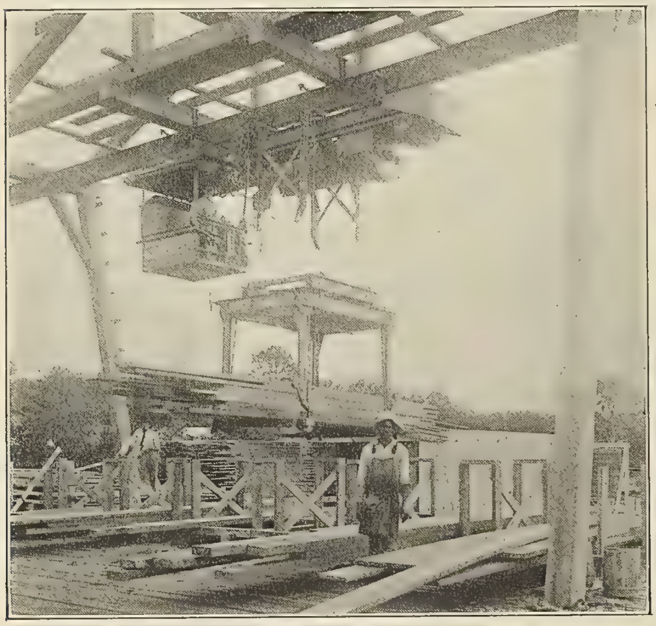
By the use of the crane the barges are unloaded in one-half the time required heretofore by a day-and-night shift of stevedores. The crane requires one operator, a ground man, and one or two men in the barge. The crane has a speed of one lift per minute—that is, it will hoist a load of two tons from the barge, turn and deposit it at the wharf house, and turn back to the barge, all in one minute.

The different transportation companies plan to have a barge or two at each terminus of the line, loading or unloading while the steamers are in transit with the barges. When a steamer reaches the terminus with its barge, there is always another one loaded and ready to be taken on the return trip. In this way the steamers are operated at their maximum efficiencies.

C. R. Mandigo, assistant engineer for the Board of Public Works, Kansas City, was in charge of the laying out of the system, and the crane was furnished by the Brown Hoisting Machinery Company, of Cleveland, Ohio.

Monorail System of Handling Lumber Installed by the West Bay Naval Stores and Lumber Company

The problem of handling lumber economically is one that confronts every lumberman. The old raised wooden tramway and lumber dolly method of handling lumber is rapidly becoming obsolete, and while the largest mills would hardly consider anything but the most modern and approved methods, even the smaller mills are beginning to realize the importance



CARRIAGE HOIST FOR HANDLING LUMBER

of meeting competition by equipping their mills with a monorail system to help reduce the operating expense.

The West Bay Naval Stores and Lumber Company have recently installed a monorail system in their plant at St. Andrew, Fla. The equipment consists of one two-motor traveling electric hoist and 1,200 feet of 15-inch I-beam, properly supported on "A" frames. The lumber is sorted into unit packages of about 1,500 feet each and is loaded directly on to barges.

The original intention of this company was to handle the lumber on push cars over elevated tramways. However, comparative figures showed conclusively that the monorail equipment would bring about a saving of $20 (£4.1) a day, which would pay for the difference in cost in a little over ninety days. These figures have since been proved to be correct.

This mill handles in the neighborhood of 40,000 feet of lumber a day, and the saving is effected not only in actual operation and maintenance, but when the mill is "down" all operating expense ceases, as there are no horses or mules to feed, nor are there constant repair charges to be considered.

The system illustrated was installed by Pawling & Harnischfeger Company, Milwaukee, Wis.

Naval Architects' Meeting

The twenty-first general meeting of the Society of Naval Architects and Marine Engineers will be held at the Engineering Societies' Building Thursday and Friday, Dec. 11 and 12. The Council will meet at three o'clock Wednesday, Dec. 10, in the Engineering Societies' Building, and proposals for membership should be mailed so as to reach the secretary on or before that date. The annual banquet will be held in the Astor Gallery of the Waldorf-Astoria at 7 P. M., Friday, Dec. 12.

A preliminary list of papers to be read at this meeting its given below:

"Relative Resistance of Some Models with Block Coefficient Constant and Other Coefficients Varied," by Naval Constructor D. W. Taylor, U. S. N., vice-president.

"Expansion and Contraction of Certain Dimensions and Their Effect on Resistance," by Prof. H. C. Sadler, member of Council.

"Experiments on the *Fulton;* Effect of Bilge Keels," by Prof. C. H. Peabody, member of Council.

"Structure of Vessels as Affected by Demand for Increased Safety," by Mr. William Gatewood, member.

"A Substitute for the Admiralty Formula," by Mr. E. A. Stevens, junior member.

"Diesel Engine as Regards Marine Propulsion," by Mr. John Reid, member.

"The Evolution of the Lightship," by Mr. George C. Cook.

"Construction and Operation of Western River Steamers," by Mr. R. C. Wilson.

"The Influence of National Policies on Ships' Design," by Capt. W. L. Rogers, U. S. N.

"Indicating and Its Relation to Scientific Designing of Engineers," by Mr. C. S. Linch, member.

"The Manufacture of Anchor Cable," by Assistant Naval Constructor J. E. Otterson, U. S. N., member.

"Strains in Hulls of Ships, Showing the Effects of Pitching and Rolling," by Mr. James E. Howard.

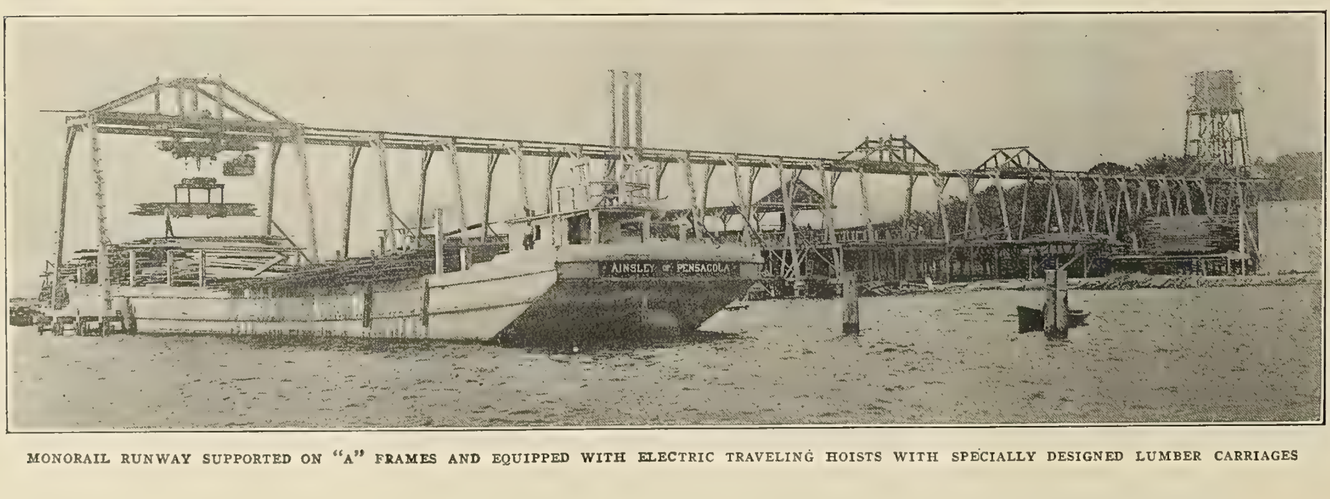
"Change of Shape of Recent Colliers," by Naval Constructor S. F. Smith, U. S. N., member.

"The Safety of Passenger Ships at Sea," by Mr. G. W. Dickie, vice-president.

"General Organization of a Navy Yard," by Capt. L. S. Van Duzer, U. S. N., associate member.

"Stability of Life Boats," by Prof. H. A. Everett, member.

"Notes on the Performance of S. S. Tyler," by Mr. E. H. Rigg, member.



MONORAIL RUNWAY SUPPORTED ON "A" FRAMES AND EQUIPPED WITH ELECTRIC TRAVELING HOISTS WITH SPECIALLY DESIGNED LUMBER CARRIAGES

Freight Burtoning at Marine Terminals

BY H. McL. HARDING*

At the port of Hamburg, the following is the latest practice for the width of quay-wall sheds, namely: "The modern sheds should be 200 feet in width, in order that the goods taken from *one* ship may be distributed *opposite* to it for further treatment."

The same conclusion, but extended in its scope, had already been deduced from a study of the great capacity obtained by high tiering by machinery.

Simplicity

By extending the principle to projecting pier sheds with *two* ships, one upon each opposite side of the pier, and for outbound as well as the inbound freight, and the width of shed not limited to 200 feet, as upon the Hamburg quays, but planned according to the length of the pier and the operating conditions, there is attained a still further simplifying of previous terminal layouts.

The practical result of this is that where gantry cranes are installed the longitudinal track loop from one end of the pier shed to the other can often be omitted, unless connection is to be made with remote warehouses. That portion of the pier or quay opposite the ship or ships is, with high tiering from movable tracks, made of size sufficient for all transshipment operations and temporary holding capacities. The long reaching gantry cranes serve the cross loops opposite the ships by direct "burtoning."

Burtoning consists in transferring the draft, or the weight of the draft, without stopping or lowering, from one hook or fall rope to another, as from the hook of one boom to the hook of another boom, or from the hook of a gantry crane to the hook of a carriage hoist.

*Consulting engineer, New York City.

FIG. 1.—TO ONE OF THE FALL ROPES IS ATTACHED A LOOP FOR THE INSERTION OF THE HOOK OF THE OTHER ROPE. THIS IS CALLED THE "BURTON LOOP"

FIG. 2.—BY SLACKENING THE ROPE, A, THE WEIGHT OF THE DRAFT IS TRANSFERRED OR BURTONED TO THE ROPE, B, AND THE DRAFT IS LOWERED TO THE PIER FLOOR

Unit of Capacity

One unit of pier length would therefore be 400 to 600 feet, equal to the length of the larger freighters. The total length of the pier may be 1,000, 1,200, or 1,500 feet, or, in fact, any length divided into units corresponding to the present or future length of ships.

The length of the present larger freighters establishes this unit, the longitudinal, from 400 to 600 feet, and this can be increased at any time by adding more cross loops. There is, as usual, the utmost flexibility in all dimensions; that is, in length, width and height of the sheds.

The cross loops with the movable tracks are, in the latest designs, supplemented by intermediate transverse loops without movable tracks, extending across the pier from one side to the other for service between the ships or between barges, lighters or river craft on one side of a pier, and the outgoing and incoming ships on the other. These loops also can be adapted for transference between vessel and cars, especially when the cars are on a projecting pier, or the cars are to the rear of the sheds on quays. On quays the transverse loops can be extended to the rearward warehouses.

Range of Cranes

By the long outreach of the gantry cranes all these loops can be served from hatchways by one or more gantry cranes. Goods from all the hatchways of a ship or other vessels can be mechanically assorted, distributed and tiered within this unit, or space of the movable and transverse track loops, opposite the ship, as well as from the hatchways of another steamship on the opposite side of the pier.

A few figures will demonstrate this. A pier may be 1,000 feet long and 300 feet wide. The space in the loops opposite

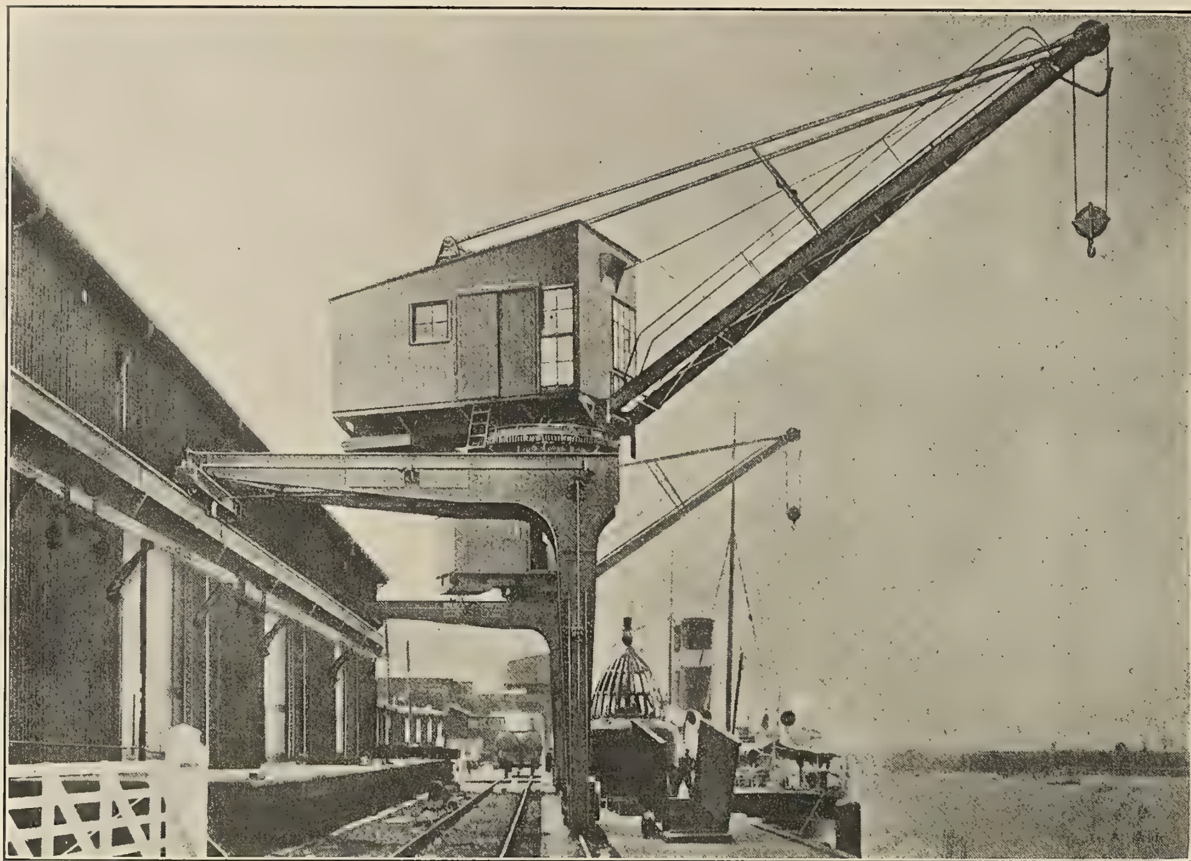


FIG. 3.—COMBINED RAILWAY AND STEAMSHIP TERMINAL EQUIPPED WITH ELECTRIC TRAVELING AND REVOLVING GANTRY CRANES OF THE HALF ARCH TYPE, QUAY SHEDS FOR TEMPORARY STORAGE OF MISCELLANEOUS FREIGHT AND RAILWAY TRACKS BETWEEN QUAY SHED AND THE QUAY WALL FOR HANDLING INBOUND AND OUTBOUND FREIGHT WHEN ASSORTING IS NOT REQUIRED

the ship, tiering on the average 20 feet high, with allowances for passageways, columns and free spaces, will give from 26,000 to 32,000 tons capacity. Low studded sheds also can be served, but the holding capacity is proportional to the height. It is a good plan to always make the first story of new sheds of ample height. One-story sheds are preferable for rapid freight movements.

As the usual average height of tiering by manual labor is 5 feet, this 400-foot loop-covered space, tiering 20 feet, is of itself equivalent to a pier over 1,400 feet in length

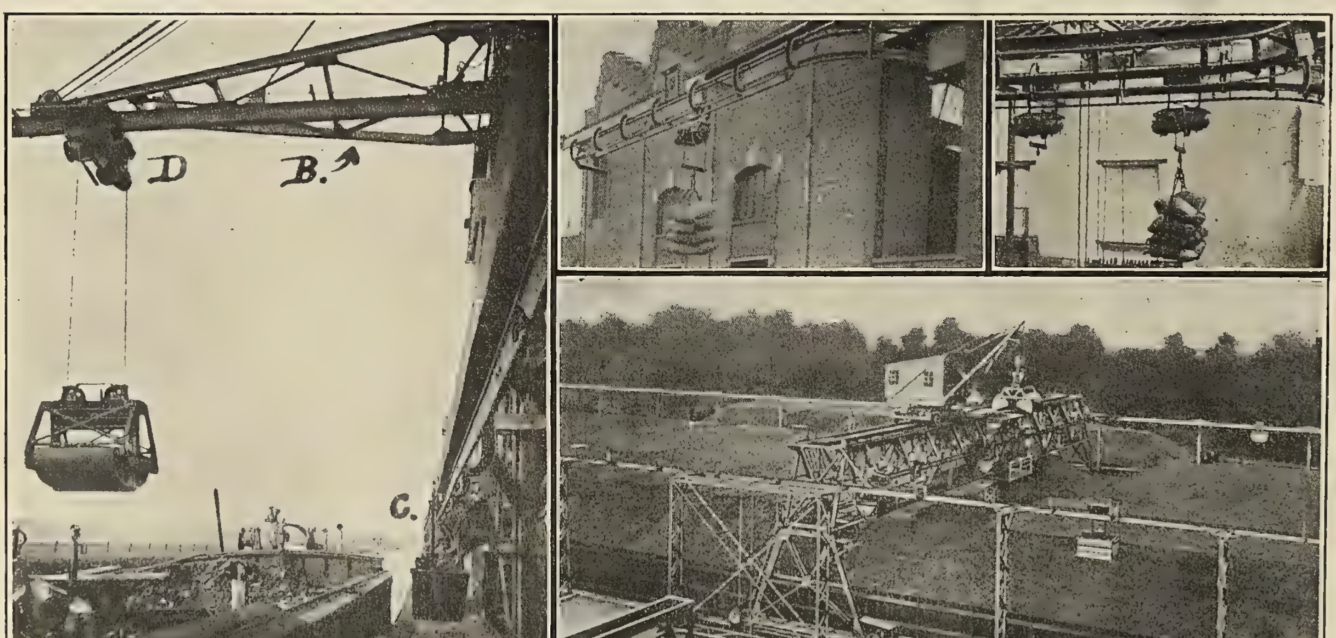


FIG. 4.—GERMAN FREIGHT HANDLING APPLIANCES AT MARINE TERMINALS

A is the burtoning track, *B* the overhead crane, *C* the carriage hoist, *D* the crane hoist. The upper views at the right show the carriage hoist, and tracks outside and inside the shed. The lower view shows a movable track bridge carrying a heavy gantry crane and hopper. The carriage buckets pass from the side fixed tracks to the cross movable tracks, serving all space in the yard.

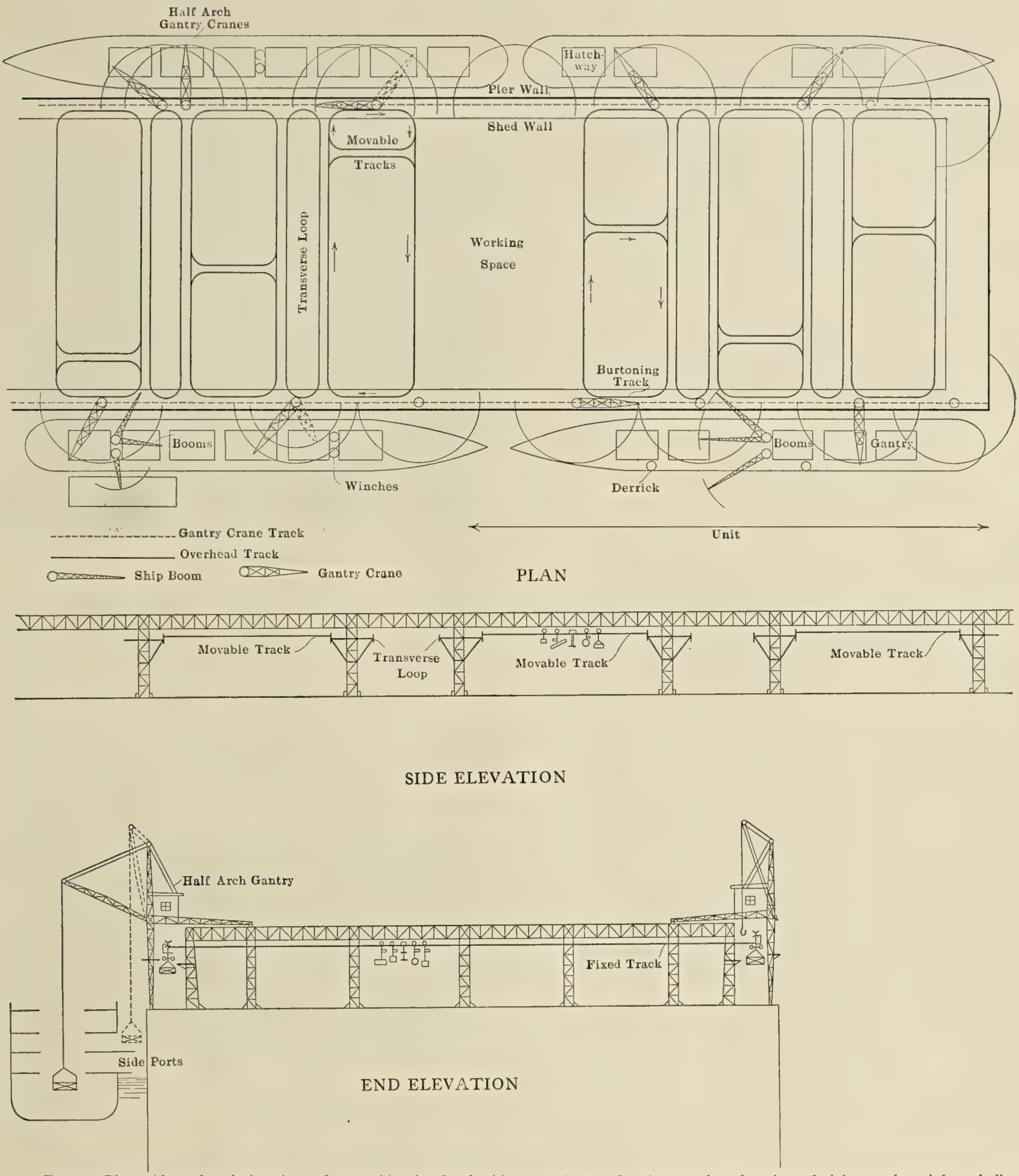


FIG. 5.—Plan, side and end elevations of steamship pier fitted with an equipment for the transfer of package freight as adapted from bulk material handling methods. With bulk material, such as ore or coal, the gantry cranes hoist and fill a hopper or reservoir from which the conveying buckets receive their loads. In the above plan, gantry cranes raise drafts of package freight which are burtoned to carriage hoists in trains of four, which constitute a reservoir equivalent to the bulk material hopper. As soon as the carriage hoists, constituting a train, have received their drafts and have started to convey and deposit the drafts, their place is filled by another train of hoists. The reverse movement is from the carriage hoists to the gantry crane, thence to the hold of the ship.

and 300 feet in width when the tiering is only five feet.

This first loop space includes only 400 feet of the 1,000 feet total length of the pier, 200 feet being permanently kept free for low tiering or for working areas. Another 400-foot length is for the second loop space. There are additional spaces at the sides of the pier not included.

This similar loop, also occupying 400 feet, will have an additional capacity of 26,000 to 32,000 tons, or another pier equivalent to 1,400 feet in length. The unoccupied working spaces represent more than one-fifth the total length of the 1,000-foot pier. Similar package freight is often tiered over 32 feet in height in pier sheds in New York harbor.

The total of 52,000 to 64,000 tons of package freight, or miscellaneous cargo, not including the working area, is in excess of the requirements for temporary freight holding for two ships. The basis of 60 cubic feet per ton, instead of the marine 40 cubic feet, was taken. Fifteen feet tiering would give three-quarters of the above capacity. By making the width of the pier 200 feet instead of 300 feet, there would be storage for about 34,000 to 42,000 tons.

The Operations

The operations of discharging consist in having one to two gantry cranes lifting plainly marked drafts from each hatchway and burtoning to carriage hoists (traveling winches) suspended from the designated overhead loop. One draft of more than one mark may be divided among the four carriage hoists of one train for assorting before distribution. The tractor-man only travels around and around his own loop, there being no switches or cross tracks for him to open or close. Loading is a simpler operation than discharging, as without any assorting and distributing the full-weight loads are burtoned from the carriage hoists of the overhead loop tracks, which project just beyond the shed line, to the gantry cranes or ship's winch, and by them lowered directly into the hold. The movable tracks operated by the floor hook-man enable every cubic foot to be served.

The speed of transference is only limited by the number and capacity of gantry cranes, as the capacity of the carriage hoists, by adding to their number, can be kept in excess of that of the cranes. This layout and method of operation, having no switches, is of the utmost simplicity and rapidity. Burtoning from one boom to another, or from the boom to a side derrick or to a cargo hoist, is employed by about every freighter in New York harbor.

The Mechanism

The ship's stationary winches, derricks and burtoning booms can be used either separately or in conjunction with and supplementing the gantry cranes. The gantry cranes can be of the full arch, half-arch or roof type, or what is called the walking gantry crane, the latter being adapted to canal terminals.

The special object of this layout was to secure the greatest rapidity in loading and discharging and increased terminal holding capacity. By making one terminal equivalent in service to two, there is no small saving effected. The overhead tracks are fixed and movable. There are trains of four carriage hoists and the tractor. No new types of machinery are involved.

Loading and Discharging Capacity

Each gantry crane can transfer in its cycle about 200 tons per hour. With four hatches, two cranes at each hatch, there would be a capacity of about 1,600 tons per hour. Each train of carriage hoists in loading has for its average cycle nearly the same capacity.

In discharging, due to assorting and distributing, the capacity is less, depending upon the number of marks.

Conclusions

First. That on the projecting piers or quays opposite each ship or ships, there should be sufficient temporary shed-holding capacity for the incoming and outgoing cargoes with ample working floor space, it not being necessary to distribute outside this space.

Second. That this is practically and economically attained by mechanical high tiering from movable tracks.

Third. That it is possible to transfer continuously between vessel and vessel, vessel and cars, as well as between vessels, cars and shed, serving cubic space without rehandling, interference and congestion.

Fourth. That by the combination of the gantry crane or the ship's winch, or both, with overhead tracks, fixed and movable, equipped with trains or tractors and carriage hoists and by burtoning, there is attained the most important factor in terminal freight movements, namely, the greatest possible rapidity in discharging and loading the greatest tonnage, including mechanical assorting, distributing and tiering.

Light Draft Motor Boats for Foreign Waters

Two light draft motor work boats, built recently by the Welin Marine Equipment Company, Long Island City, N. Y., are shown in Figs. 1 and 2. The boat illustrated in Fig. 1 is of steel, 36 feet long, built for cargo purposes, and fitted with a

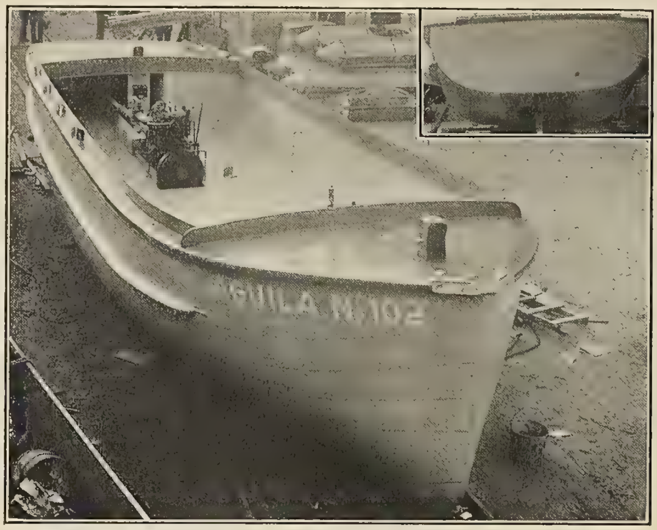


FIG. 1

16 horsepower Buffalo engine operating a single propeller in a tunnel at the stern. This boat is one of several built for service in Mexico. Fig. 2 shows a twin-screw 54-foot mail and passenger boat, fitted with two 24 horsepower Sterling engines,

FIG. 2

designed to give the boat a speed of about 15 miles per hour. This boat was built for service on the South American rivers.

Shallow Draft Steamers in India.—Some of the largest fleets of shallow draft steamers are to be found on the great rivers of India. The Irrawaddy, navigable from Bhamo down to the sea, with the numerous creeks in the vicinity of Rangoon, is particularly adapted to navigation by vessels of very restricted draft. At present Messrs. William Denny & Bros., Dumbarton, are constructing their 266th vessel for the Irrawaddy Flotilla Company, owners of a varied fleet, which carries on an enormous business on this river. Side-wheel, stern-wheel and single and twin-screw vessels have been employed as the conditions of trade required. The largest vessels are the mail steamers, of which the *P. S. India*, 310 feet by 46 feet by 11 feet, is a representative type.

McAndrew's Floating School

BY CAPTAIN C. A. McALLISTER*

"In closing my remarks on electricity, I want to impress upon you that, although it is not known definitely what electricity is, its effects are very well known, and there is no great mystery about it. You do not get something for nothing, as many beginners are apt to think. For all electrical energy generated and used, there is a still greater amount of mechanical energy exerted in its production. If the current comes from a battery, you have to produce it by the disintegration or wasting away of the zincs; if from a dynamo, it takes coal to produce it. The only free electricity we get is that from the clouds in the form of lightning, but no one has, as yet, found a method of utilizing currents from that source."

"What about Jersey lightning?" inquired O'Rourke.

"I suppose you refer to the New Jersey drink known as 'applejack,' and if that's the case, I haven't heard that that is free, either, but I understand its results are about as fatal as the lightning we get from the clouds. You probably know more about that than any of the others here."

CHAPTER XVI

Pipes and Valves

"The school will be in order," demanded McAndrew, as he entered "Highbrow Hall," it having been dubbed that by O'Rourke. The cause of this remark was a heated discussion which was being carried on by the four students as to whether the United States or Germany had the larger navy. Gus Schmidt and Nelson were maintaining that Germany was the more powerful, while Pierce and O'Rourke strenuously insisted that Uncle Sam was the superior on the water.

"Never mind about the navies of the world," said the instructor, "they're big enough to look after themselves—what you boys should be interested in is to be of some use to the merchant marine. I want to discuss this evening the subject

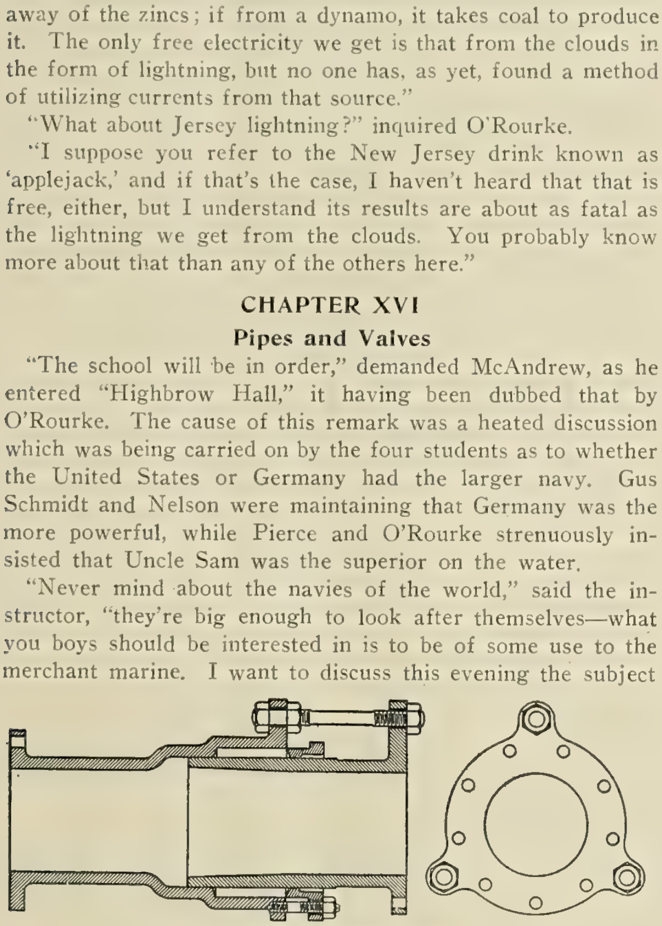


FIG. 25.—EXPANSION JOINT

of pipes and valves. We have dealt with boilers, engines, pumps, etc., and now we want to connect them up. This is, therefore, a very important matter, as much depends in the successful operation of marine machinery on having proper pipes to carry the steam and water and proper valves to control them. Piping on board ship can be divided into three general classes, *i. e.,* steam pipes, exhaust pipes and water pipes.

"The main steam pipe system is naturally of the greatest importance, as through this system the steam is passed from the boilers to the main engine.

"The material generally used for the main steam pipe is copper, on account of its great ductility, the ease with which it is worked and its freedom from corrosion. For sizes up to 10 and 12 inches in diameter it is made of seamless drawn material in order to avoid the brazed seam, which is liable to be the cause of leakages. As copper expands or increases in length when heated up to the temperature of the steam it carries, great care is exercised by designers to make arrangements for this expansion to be taken up without damaging the pipe or its flanges. One method of accomplishing this is by means of the ordinary 'slip joint,' as shown in this sketch.

"These, however, cause considerable work in order to have them properly packed, and have been known to pull apart and scald people who happened to be in the vicinity. The best method is to lay out the pipes so that there will be a number of large curves or bends in their length; the expansion then being taken up by the slight bending of the pipes. That is the reason you never see a large steam pipe run straight. As all pipes must be in such lengths as to get them in and out of the spaces they occupy for the purpose of making repairs, the sections must be securely bolted together. This, you may have noted, is accomplished by expanding the ends of the pipes into rings of cast iron or composition, called flanges, and after putting in some packing between the flanges, they are bolted up tightly together by means of a number of bolts of sizes to suit the diameter of the flanges. The making and keeping tight of these pipe joints is one of the most serious parts of an engineer's business. Various kinds of patented packings are used for making these so-called 'gaskets' for pipe joints; many of them are excellent, some are good, and others are not worth two hoots. You will each have to learn from your own experience which is the best material to use, but be sure and get the kind which keeps the tightest joint and lasts the longest."

"Which one is that?" inquired Nelson.

"Ask each packing agent who tries to sell you some, and you will find that he has the goods," was the reply. "Some night when you are compelled to work an extra watch to replace a blown-out joint over the top of a hot boiler, just make a record of your thoughts regarding that particular kind of packing, and when you get back in port show it to the agent whom you patronized."

"Wouldn't we have to write those thoughts on some asbestos paper?" inquired O'Rourke.

"I think you would," said McAndrew.

"Main steam pipes on some vessels carrying very high-pressure steam are made of seamless drawn steel, on account of its strength being greater than that of copper. The disadvantages of steel for piping are the difficulty in making easy bends and its liability to corrosion. The flanges on steel pipes are sometimes made solid with the pipe, and this makes the strongest job obtainable for a joint of this kind.

"Auxiliary steam piping is made of copper, brass, iron or steel, according to the class of work. Seamless drawn copper is about the best that can be used, while ordinary wrought iron piping with screwed joints is often used in the cheaper kinds of work.

"Exhaust piping for steam is made of copper or iron, and it only differs from steam piping in being made thinner, as it does not have to withstand so high a pressure.

"Speaking of iron piping, O'Rourke, did you ever see a piece of 7/8-inch pipe?"

"Lots of it," replied the ever-ready.

"Well, I'm glad to hear it," said McAndrew, "you are probably the only one living who has ever seen that size; as a matter of fact pipe manufacturers do not make any 7/8-inch pipe or any 5/8-inch pipe, either. Just why they don't I am unable to say, but the old-timers who originated pipes for use around gas works probably had good reasons for not doing so.

"Just jot this down in your memories: Pipe sizes are 1/8 inch, 1/4 inch, 3/8 inch, 1/2 inch, 3/4 inch, 1 inch, 1 1/4 inches, 1 1/2 inches, 2 inches, 2 1/2 inches, 3 inches, 3 1/2 inches, 4 inches, 4 1/2

* Engineer-in-Chief, U. S. Revenue Cutter Service.

inches, 5 inches, and above that in even inches. If any one ever tells you to go and get them a piece of 1⅛-inch pipe, or any other size which is not in the list I have given you, they are trying to run you. Just tell them that the storekeeper is all out of that particular size.

"If any one ever asks you the diameter of a 1-inch pipe, don't think that it is a similar question to 'What times does the 12 o'clock train leave?' for it is not. While the 12 o'clock train may leave at 12 o'clock, a 1-inch pipe is always 1.05 inches inside diameter; a ½-inch pipe is .62-inch inside diameter, or nearly ⅝ inch. Here, again, the old-time gas engineers got in their work; but if you don't like standard sizes you can go without them; they have come to stay, and you might as well try to buy cheese by the yard instead of by the pound as to get manufacturers to change these old-established standards.

"For high pressures, pipes are made 'extra heavy' and 'double extra heavy,' but the inside diameters are the same, the excess metal being put on the outside.

"Brass pipes are made of iron-pipe size, and are frequently used in small-sized steam and exhaust pipes. Iron and brass pipes are not bent so easily as copper pipes, hence to change direction in a pipe lead, or to reduce or increase sizes, various standard fittings are used. These, naturally, are made of what is known as 'malleable iron'—a cast iron which is not as brittle as ordinary cast iron. Hence if the lead of the pipe is to change at right angles, an elbow is used; if one pipe is to branch off at right angles to another pipe, a 'tee' is used; if two pipes are to be joined together for permanent use, a 'coupling' is used; if sections of piping are to be put up so that they can be taken down, 'unions' are used, and let me say right here that for marine work you can't use too many 'unions,' as they're mighty handy fittings; then there are 'plugs,' 'caps,' 'reducers,' and various other devices for the convenient installation of piping, all of them made with standard pipe threads.

"For water piping on board ship, copper is almost always used for pipes which handle salt water, although in some cases for bilge pipes, lead is used. Copper has the advantage of not being corroded by salt water, and as it can be bent easily it makes an ideal material for such purposes. For the feed pipes, seamless drawn brass is frequently used for the straight parts and copper pipe for the bends. For the fire main seamless drawn brass is the best material, but as this is very expensive it is seldom used. A very good substitute material for use as fire mains is wrought iron or steel lined with lead. The iron or steel furnishes ample strength to resist the pressure, and the lead lining prevents corrosion of the interior, providing always that no leaks develop through the lining."

"What do you mean by 'seamless drawn?'" asked one of the class.

"When pipes were first made they were rolled up into cylindrical form out of sheet metal, and the seam brazed in the case of copper and riveted for iron or steel. A joint of either kind is an element of weakness, and leaks frequently start from imperfections in the welding or brazing of the joint. Of late years the art of drawing metal pipes from a solid block or ingot over a mandrel has taken great strides, so that to-day it is possible to buy either steel or copper pipes of any size up to 12 inches and over in diameter which have been drawn solid, and consequently have no seams. Although at present the larger sizes of seamless pipe cost more than built-up pipes, the greater safety, due to the absence of joints, makes it advisable to use this pipe, especially for steam and water piping subjected to high pressures.

"In main feed pipes on board ship it is always necessary to make them in several lengths to facilitate their installation in crowded spaces, and to make them accessible for repairs. The location of flanges joining these sections together should be very carefully planned out in order to provide freedom of access in making new joints. When a leak occurs in a feed pipe joint it must be repaired very quickly, as boilers under steam won't run long without water. Every boiler is, of course, provided with both a main and an auxiliary feed connection, but no engineer ever feels very comfortable while even one of these pipe connections is out of order.

"Bilge pipes are sometimes made of lead, as I previously stated, but more often they are made of galvanized iron on account of the less cost. In connection with bilge piping it will be well to tell you something about the methods of getting water out of a ship's bilge, as every marine examiner will ask you something about that. The usual form of the question is, 'State how many means there are for getting water out of the bilges?' Perhaps you can answer it off-hand, O'Rourke."

"Sure," said that worthy. "Start the donkey pump, and if that doesn't do the trick put the firemen to work bailing it out with buckets."

"Starting the donkey pump would do for ordinary circumstances, but in an emergency, if you were put to work bailing out the bilges, I am afraid the ship would sink before you carried more than two or three bucketsful up the ladders; that is, if you didn't work any faster than you usually do.

"The usual method of pumping out bilges is by the independent bilge pump with which most ships are furnished. This pump can be connected to all compartments of the ship through the manifold, from which pipes lead to all bilges. You may have noticed that valve near the circulating pump which is always kept closed, and should be locked or tied shut. In a great emergency, such as the ship grounding or in collision, the main circulating pump can be connected so as to pump out the bilges, by closing the main injection valves, and opening this emergency or bilge injection valve, as it is termed. On most ships the auxiliary, or donkey pump, usually is connected to the bilge manifold, so that it may also be put to pumping out the bilges.

"Many ships are provided with what is known as a 'bilge ejector,' whereby a jet of steam starts and maintains a syphon effect which forces the bilge water up and overboard. Such a contrivance is too wasteful of steam, and consequently of fresh water, to be used very freely on vessels plying the ocean. If all these devices fail to keep the water in check, then the best thing you can do is to pack your grip and take to the boats."

"How about saying your prayers?" inquired O'Rourke.

"I don't think that would work in your case," retorted McAndrew.

"A very important point in connection with pumping out bilges is to see that the strainers are cleared. The bilges of all ships, as you may know, usually contain ashes, chunks of waste, shavings and other refuse, and they have been known to contain a fireman's undershirt or overalls. These things if drawn into the bilge suction pipes would soon choke them up and the pumps would be useless. Hence it is that the end of every pipe is fitted with some form of a perforated strainer to catch the refuse before it can get into the pipes. The ordinary form is known as the box strainer, which, as its name indicates, is shaped like a box, and has all its sides and its bottom perforated with three-eighths or one-half inch holes. The top of the box is made easily removable so that it can be cleaned out. Unless given attention frequently these strainers themselves become plugged up with dirt and refuse, and you young men will probably never appreciate the importance of keeping them cleaned out until you are called on some night while the ship is rolling and pitching in a gale of wind to dive down in bilge water up to your armpits for the purpose of digging bunches of waste and handfuls of ashes out of the strainer boxes. An old-time chief engineer in the navy conferred a lasting boon on seafaring men by inventing what is known as the 'Macomb strainer,' a device whereby the water is strained through a metal basket in a cast iron body with a removable top. By simply removing a clamp in the top of the strainer body the basket can be lifted out and emptied in two minutes. This invention has saved much profanity on shipboard, and probably many ships.

"In line with a talk on piping, and incidentally with profanity-provoking devices, we might stop casually and consider the steam trap, a necessary evil fitted to all steam plants. The primary purpose of a steam trap is to separate the water from steam in the numerous drains with which all marine machinery must be fitted. This is accomplished, or, I might add, is tried to be accomplished, in two principal ways: one by the automatic filling and emptying of buckets floating in the water of condensation, and the other by difference of expansion in metals as affected by the variance in the temperatures of steam and water. There are about as many different styles of steam traps as there are applicants for an easy job, but there are not more than two or three of these styles fit to use on board ship. I hesitate to tell you which they are, as I am a little uncertain even about their efficiency at all times.

"Of equal importance to the piping on board ship are the valves which control the flow of steam and water through them. Most of the work of the engineer, while the vessel is under way, is devoted to the opening, closing and regulating of valves. Knowing how and when to perform these functions

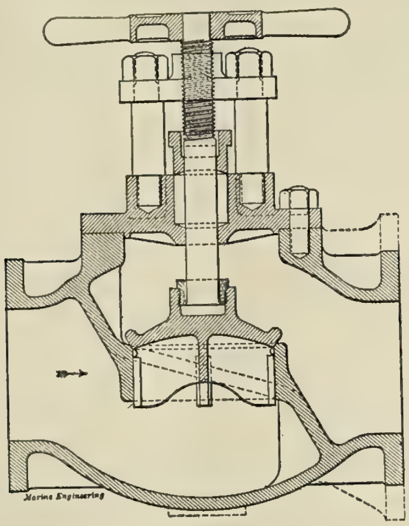


FIG. 26.—GLOBE VALVE

constitutes a large part of an engineer's practical knowledge. The efficient working of marine machinery is largely dependent upon the proper manipulation of valves, and on the other hand nine-tenths of all the trouble on board ship is occasioned by the wrong manipulation of these important details. With this introduction to the subject you can readily see that it will be well to pay a little attention to them. The valves used on shipboard may be divided into principal classes—angle and globe, stop and check, and gate valves, and various combinations of these types.

"A globe valve may be defined as one in which the steam, water, etc., enters and leaves the valve flowing in the same direction; an angle valve is one in which the steam, water, etc., enters the valve flowing in one direction and leaves the valve flowing in a direction usually at right angles to that in which it enters. Figs. 26 and 27 will illustrate these two types.

"A stop valve is one in which the disk is under absolute control of the hand wheel, and permits of flow through it in either direction.

"A check valve is one in which the stem is not connected with the disk, and permits of flow through it in only one direction. It can, however, be shut off by screwing down on the hand wheel.

"A gate valve is one in which the disk or gate is set at right angles to the direction of flow, and is at all times under control of the hand wheel. (See Fig. 28.)

"A cock is in reality a valve of the simplest design, wherein a conical plug is fitted in the body, and the flow of steam or water through it is regulated accordingly as the slit through the plug is placed in line with the direction of the flow or at right angles to it.

"Valves of all descriptions are made principally of the best quality of cast iron, as that is the cheapest and best adapted metal for the purpose. Composition is frequently used for

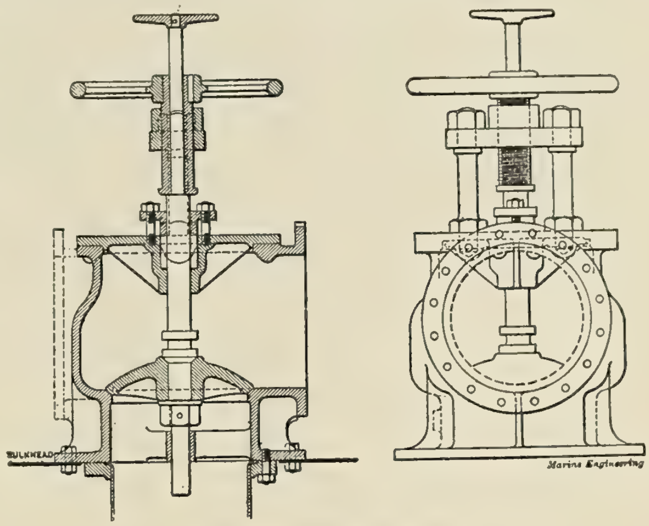


FIG. 27.—ANGLE STOP VALVE

small valves and for larger valves in high-class work, on account of its freedom from corrosion and greater strength. Its increased cost, however, precludes its extensive use.

"Cast steel is used to some extent for valves subjected to very high steam pressures, owing to its great tensile strength, but the difficulty of obtaining good castings, free from blow-

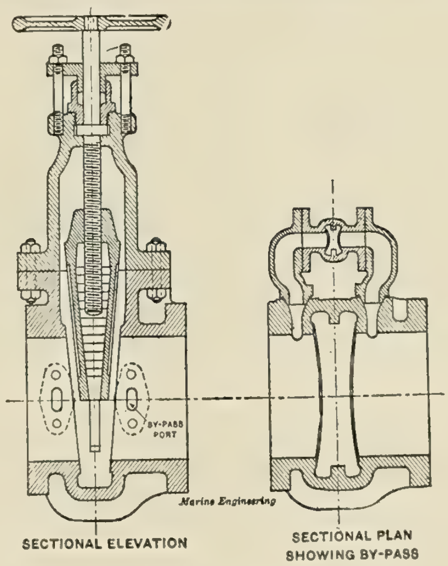


FIG. 28.—GATE VALVE

holes, limits its use to places where the greater strength is absolutely necessary.

"It is usual to have all cast iron valves 'brass mounted'; that is, to fit them with composition seats, disks, stems and stuffing-boxes, as these are the parts subjected to the greatest wear.

"Seats of valves become grooved by the constant flow of steam or water, and if not attended to regularly are bound to leak. Therefore one of the frequent duties of an engineer is to 'grind in' leaky valves, an operation which consists of removing the valve covers, covering the seats with a ground-glass paste and revolving the disk in place until all grooves are removed. A valve reseating machine is a device for 'grinding in' valves mechanically while in place, the same as it would be done if the valve was removed and placed in a lathe. Such a device is a necessity in order to keep valves on a modern ship always tight."

"Chief, what is a reducing valve used for?" interrupted Pierce.

"Reducing valves are of comparatively recent use around steam plants, and have been made a necessity by the constantly increasing steam pressures now being used on board ship. While these high pressures are necessary for multiple-cylinder main engines to increase the economy of working, there are still certain auxiliaries on all ships which use lower steam pressures. Among these may be mentioned the ordinary reciprocating dynamo engines, the steering engine, the windlass engine, the bilge pumps, the heating apparatus, steam jackets, etc., and, in fact, wherever it is desirable to have low-pressure steam at a uniform pressure. These are devices whereby the high-pressure steam from the boilers may be reduced and delivered at almost any pressure desirable by regulating the reducer, after which, no matter how much the boiler pressure may fluctuate, a steady lower pressure is maintained for the auxiliaries."

"What is a relief valve, and why are they fitted on some pumps?" inquired Schmidt.

"A relief valve is simply a small safety valve," replied McAndrew. "I have already told you why these are useful on the main engines. On some pumps, and especially fire pumps, it frequently happens that a careless oiler or machinist will start the pump full speed, and if there are not sufficient openings of the stop valves along the fire mains the pressure might rupture the pipe. For that reason one or more relief safety valves, set to blow off at a safe pressure, are fitted in the fire main, usually in the engine room, where the escaping water can do no particular harm.

"I have already explained to you that a valve need only be opened a vertical distance equal to one-fourth its diameter, and I hope you will bear that fact in mind. Remember, also, what I told you about not opening a steam valve quickly. That, however, does not apply to water valves, as they should be opened as quickly as possible.

"In closing this lecture I will call your attention to the pipe covering. In general all pipes transmitting either steam or hot water should be covered with non-conducting material, such as hair-felt for low pressures, and magnesia or asbestos, or the various components of each for the higher temperatures. Escaping heat not only lowers the efficiency of any steam engine, but it adds to the discomfiture of the men who have to operate the machinery. If you ever have to do any pipe covering remember that you should not cover any of the joints, as it is often necessary to get at them quickly to make new joints, or to set up on them when they leak. All pipe covering should be encased in canvas, and it should be sewed on instead of being pasted, as some contractors like to do.

"We have about covered in a general way all parts of a marine installation, and from now on I will direct your attention to what may be termed specialties, and go into a number of subjects with which you will have to be familiar before getting your ticket."

(To be continued.)

Fire Loss at Sea.—The loss of the Uranium Steamship Company's passenger and cargo steamer *Volturno*, resulting in the death of 132 persons, while one of the greatest sea tragedies in recent months, is but one of the many disasters which have occurred at sea on account of fire. According to reports by the Liverpool Underwriters' Association, during the first nine months of the present year, no less than 336 total and partial losses through fire at sea have been recorded

Motor Tank Ship Wotan

The arrival in New York on October 3 of the German-American Petroleum Company's new motor tank ship *Wotan* aroused considerable interest among naval architects and marine engineers. The *Wotan* is a large, splendidly-equipped tank ship. The dimensions are: Length, 404 feet; beam, 52 feet 3 inches; depth, 29 feet 6 inches; draft loaded, 23 feet; cargo capacity, 6,780 tons of oil, in addition to 900 tons of bunker oil and 100 tons of water. The motive power consists of a single six-cylinder, two-cycle Diesel engine of the Carels type, built by the Reiherstieg Schiffwerft und Maschinenfabrik

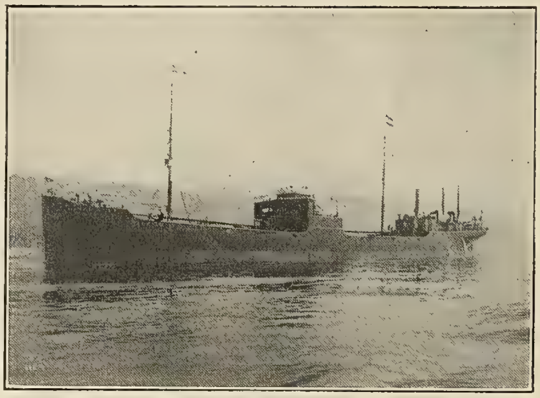


FIG. 1.—OIL TANK MOTOR SHIP WOTAN

of Hamburg, and designed to develop 2,900 indicated horsepower at 90 revolutions per minute. The voyage from Hamburg to New York was accomplished in fifteen and one-half days at an average speed of 8.1 knots. The engine averaged a speed of 79 revolutions per minute, developing 2,250 horsepower, and the fuel consumption figured out at 131 grams per indicated horsepower per hour. The fuel used was Roumanian gas oil of .86 specific gravity. The entire voyage was made without mishap, and after a cargo of oil was shipped at the Standard Oil Company's docks the vessel sailed again on October 9 for Flushing.

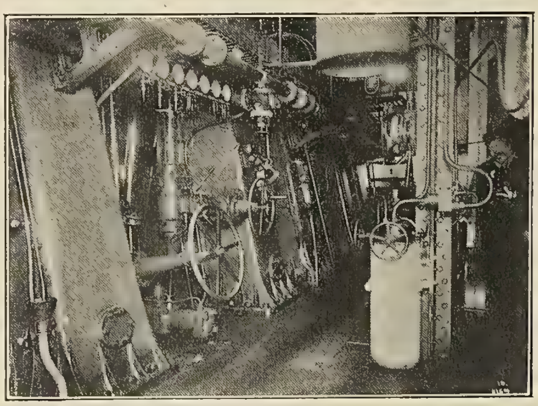


FIG. 2.—MANEUVERING GEAR IN ENGINE ROOM

The *Wotan's* engine is the largest single unit so far placed on board ship and conforms in design and arrangement to the usual type of marine Carels Diesel engine. The main air compressor is driven off the main engine. An auxiliary air compressor driven by a three-cylinder high-speed, four cycle Diesel motor is also provided. Two electric generators are installed, one driven by a two-cylinder, four-cycle oil motor, built by Messrs. Frericks, and the other by a steam engine. A two-furnace, oil-fired Scotch boiler, located on the main deck forward of the engine room, supplies steam at about 120 pounds' pressure for deck machinery, pumps, etc., while in port, and a small low-pressure boiler, coke-fired, provides steam for heating purposes when the large boiler is shut down.

Letters from Practical Marine Engineers

Incidents Relating to the Design, Care and Handling of Marine Engines, Boilers and Auxiliaries; Breakdown at Sea and Repairs

The Strength of Columns

U. S. Navy Column Tables Not Based Upon a Fundamental Misconception

Although no longer connected with the Bureau of Construction and Repair of the United States Navy, I cannot resist the suggestion of Mr. A. J. Murray that I reply to his very interesting article on columns appearing in the July and August numbers of INTERNATIONAL MARINE ENGINEERING, especially as I find it impossible to agree with some of Mr. Murray's conclusions, and in particular with his contention

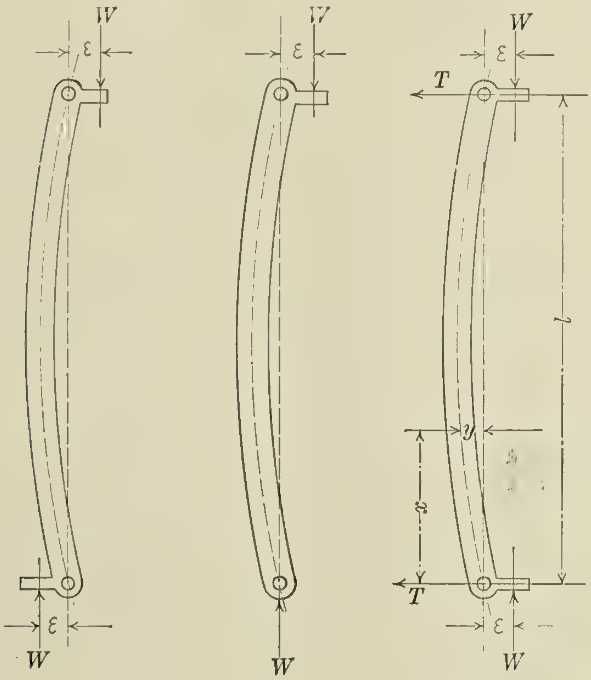


FIG. 1

that Moncrief's formula, from which the navy column tables were derived, is based upon a fundamental misconception.

Mr. Murray assumes that there is at each end of the column a horizontal reaction, the effect of which is to modify the equation of bending, introducing a factor not allowed for by Moncrief. In order to determine the correctness of Mr. Murray's deductions we will assume that the horizontal reactions exist just as Mr. Murray says they do, but will examine the consequent conditions of flexure in a somewhat different manner, following closely the method commonly used in analyzing the bending of beams.

It may be stated in the first place that if all the eccentricity in a column, due to non-central loading, accidentally imposed bending moments at the pins, non-uniformity of fabrication, etc., be summed up as single vertical eccentricities at the two ends, the eccentricities at the ends may be equal and acting on the same side of the axis, or equal and acting on opposite sides of the axis, or the eccentricity at one end may be zero, with, of course, an infinite variety of intermediate combinations. This is illustrated by Fig. 1.

It will be seen at once that the case of equal eccentricities, acting on the same side of the axis, produces the most severe bending in the column, and hence this condition only need be examined. Mr. Murray apparently assumes this condition, although some of his results do not agree with this assumption. For example, he derives a curve of bending moments that is not symmetrical with respect to the two ends, a result that is clearly impossible when the conditions at the two ends are assumed to be identical.

Now taking the reaction at either end as T, we have for the bending moment at any section

$$M_x = W\ (\epsilon + y) - T\ (l - x),$$

whence we can write

$$\frac{EId^2y}{dx^2} = W\ (\epsilon + y) - T\ (l - x).$$

On integrating we have

$$\frac{EIdy}{dx} = W\ (\epsilon + y)\ x - Tlx + \frac{Tx^2}{2} + C.$$

Now the bending moment must be a maximum at the middle of the length of the column, since the conditions at the two ends are alike, and hence $\frac{dy}{dx} = o$ when $x = \frac{l}{2}$, which enables us to evaluate the first constant of integration, giving

$$C = \frac{3Tl^2}{8} - \frac{Wl}{2}\ (\epsilon + y).$$

Substituting this in our equation we have

$$\frac{EIdy}{dx} = W\ (\epsilon + y)\ x - Tlx + \frac{Tx^2}{2} + \frac{3Tl^2}{8} - \frac{Wl}{2}\ (\epsilon + y)$$

On integrating again we have

$$EIy = \frac{W\ (\epsilon + y)\ x^2}{2} - \frac{Tlx^2}{2} + \frac{Tx^3}{6} + \frac{3Tl^2x}{8} - \frac{Wl}{2}\ (\epsilon + y)\ x + C'.$$

Now $x = o$ when $y = o$, enabling us to evaluate the second constant of integration, giving

$$C' = o.$$

Also, when $x = l$, $y = o$, so that we can reduce the equation to

$$\frac{W\epsilon l^2}{2} - \frac{Tl^3}{2} + \frac{Tl^3}{6} + \frac{3Tl^3}{8} - \frac{W\epsilon l^2}{2} = o,$$

or

$$-12T + 4T + 9T = o.$$

Whence we find that $T = o$.

In other words, the horizontal reactions at the ends, the neglect of which Mr. Murray considers as a fundamental misconception nullifying the value of the Navy Column Tables are, as a matter of fact, non-existent. Mr. Murray's equations are therefore themselves based upon a "fundamental misconception" which may be found at the very beginning of his article, where he states that the necessary condition for equilibrium is that

$$T \times L = W \times \epsilon,$$

an assumption that neglects the resistance to bending of the column itself as a part of the static condition producing equilibrium.

Mr. Murray's contention that the formula from which the Navy Column Tables were derived is based upon a fundamental misconception is therefore not sustained, and the formulæ adduced by Mr. Murray are themselves based upon unsound mechanics.

Bridgeport, Conn. Earle Anderson.

Salving a Sunken Car Float

Early in the morning of Sept. 22 the Pennsylvania Railroad car float No. 13, carrying eight freight cars, some of which were loaded, sank at her berth on the north side of pier 10 at the foot of Walnut street, Philadelphia, Pa. Three of the cars rolled off the float but the others remained on the float.

On the evening of Sept. 25 the Pennsylvania Railroad wrecking tug *Commissioner* arrived on the scene, and the next day began the work of raising the cars and the float. A diver went down and adjusted slings around the cars. On the 26th the first two cars were raised and placed upon another car float; on the 27th two more cars were raised, and by noon of the 30th all of the cars had been salved. The float, which is built of wood, came to the surface when the cars were removed from it and was towed by the wrecking tug to the Quigley & Dorp shipyard, Camden, N. J. Some of the cars and the float were considerably damaged, and the Bush Line steamer *West River* on the south side of pier 9 was held at her berth by the accident from the 22d to the 29th.

FIG. 1.—SUNKEN CAR FLOAT

FIG. 2.—RAISING THE SUNKEN CARS

Fig. 1 shows the sunken float as it appeared at about half tide, and Fig. 2 shows one of the cars raised from the water and being swung onto another car float. The work of raising the eight cars and placing them on car floats occupied four and a half days.

Philadelphia, Pa. H. H. Thayer, Jr.

Total Breakdown of Float Feathering Gear of a Paddle Steamer

It sometimes happens that when a breakdown occurs no visible cause can be discovered to account for it. A case in point is the following, when the feathering gear of the paddle floats of a side-wheel steamer was completely wrecked. The paddle wheel had seven floats provided with the usual radius rods and driving arm. Each of the six radius rods was bent as indicated in the sketch, Fig. 1, and broken off at about the center, the diameter of the rods at the point of fracture

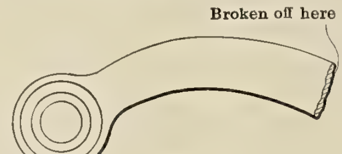


Fig. 1

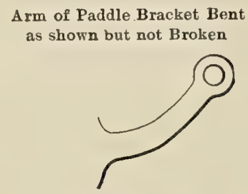


Fig. 2

being 2¼ inches. One of the paddle float brackets was also bent as shown in Fig. 2. The reason for this was due to the feathering eccentric sticking, but the cause of the breakdown is more difficult to show. It is certainly a most unusual occurrence and which cannot easily be accounted for. The superintendent of the line of steamers advanced the theory that the bolts connecting the driving rod to the feathering eccentric had either got sheared off or come loose and dropped out, allowing the driver to come adrift from the eccentric, hence causing the breakdown. Perhaps some other reader has come across a similar instance or could put forward a theory other than that already stated to account for this most unusual and inexplicable breakdown.

Glasgow. "Ison."

Lloyd's Register Shipbuilding Returns.—Figures compiled by Lloyd's Register of Shipping, which only take into account vessels actually under construction, show that, excluding warships, 508 vessels of 1,987,254 gross tons were under construction in the United Kingdom at the close of the quarter ended Sept. 30. The tonnage now under construction is 16,000 tons less than that which was in hand at the end of the last quarter, but exceeds by about 140,000 tons the tonnage building in September, 1912.

Marine Articles in the Engineering Press

The Cunard Canadian Liner Andania.—The *Andania* is one of a pair of sister ships built by Messrs. Scotts' Shipbuilding & Engineering Company, Greenock, for the Canadian service of the Cunard Line. The vessel is 540 feet long, 64 feet beam and 46 feet depth with accommodations for 520 second class and 1,620 third class passengers. No first class accommodation is provided and the third class passengers are berthed in cabins instead of in the usual steerage quarters. Propulsion is by two sets of reciprocating engines, developing a total of 8,000 indicated horsepower. 1 illustration. 700 words.—*Engineering*, August 15.

The Imperial Ottoman Battleship Reshadieh.—The Imperial Ottoman battleship *Reshadieh*, launched September 3 from the Naval Construction Works of Messrs. Vickers, Ltd., at Barrow-in-Furness, is 525 feet long, 91 feet beam and has a displacement under normal conditions of 23,000 tons at a draft of 28 feet. The armor protection is very complete, consisting of 12-inch armor amidships, with the upper strakes reduced to 9 and 8 inches. The main armament consists of ten 13.5-inch guns mounted in pairs in five barbarettes on the centerline of the ship. The secondary armament includes sixteen 6-inch guns. Propulsion is by Parsons turbines of 31,000 shaft horsepower operating four shafts and supplied with steam by Babcock & Wilcox boilers. The designed speed is 21 knots. 850 words.—*Engineering*, August 29.

The Quadruple Screw Steamers Oosterdyk and Westerdyk.—These vessels are modern cargo steamers designed by Mr. H. van Helden and built by Messrs. Irving's Shipbuilding & Dry Docks Company, Ltd., West Hartlepool, for the Holland-America Company of Rotterdam. The dimensions are: Length, 470 feet; beam, 55 feet; depth, molded to shelter deck, 41 feet 7½ inches. The cargo loading and discharging gear is very complete and the accommodations for the officers and crew are fitted out with every possible improvement for the comfort of the *personnel* at sea, in accordance with the usual practice of the Holland-America Company. The machinery, built by Messrs. Richardsons, Westgarth & Company, Ltd., Hartlepool, consists of quardruple balanced four crank engines with cylinders 27½, 37¾, 55 and 84 inches diameter by 60 inches stroke, supplied with steam at 215 pounds pressure by six Scotch boilers. A feature of the engine is the fitting of a Contraflo condenser with its appropriate accessories. A brief description is given of the auxiliary machinery and equipment of the vessels. 6 illustrations. 900 words.—*Engineering*, August 29.

Typical Ships. No. II: A Harbor Tug.—The harbor tug described is one of a pair of steel side paddle tugs just delivered to the Admiralty by J. I. Thornycroft & Company, Ltd., of Southampton. The vessel is 145 feet in length between perpendiculars, 28 feet beam and 15 feet depth, equipped with two sets of diagonal compound condensing engines with cylinders 22 inches and 40 inches diameter by 60 inches stroke, giving a combined horsepower of 1,250, which drives the tug at a speed of about 12 knots. The boiler is placed aft of the engine room. That a side wheel tug should be classed as a "typical modern ship" seems fully justified in view of the service for which this tug is built. She is stationed at Sheerness, where there is a strong tide, and where there is only a small space to maneuver in with large vessels to handle. Obviously such a tug is not suitable for sea-going towing purposes, but, where it is necessary to handle large vessels in restricted quarters by pushing the huge vessels about, this type of power has been shown by experience superior to the screw type of tug. 3 illustrations. 2,500 words.—*The Engineer*, October 10.

Belt Coal Conveyor at Middlesbrough.—An installation made on the north side of the North-Eastern Railway Company's dock estate at Middlesbrough for conveying coal from railway cars to the hold of a ship consists of a coal carrying belt 42 inches broad and 310 feet long traveling up a long incline fixed at an angle of about 20 degrees to the ground level. It is fed at the shore end from a hopper of 30 tons capacity constructed in the embankment under the railway line. Means are provided for regulating the feeding of coal to the conveyor and for taking up the slack and reducing the slip in the conveyor. The conveyor delivers the coal to a tower on the dock, which is provided with a loading jib fitted with hinged connecting chutes down which the coal is delivered by gravity to the hatch of the vessel. Power is provided for raising and lowering the jib and moving it in a lateral direction 12 degrees each side of the centerline. When the jib is raised to a height too great for the coal to fall by gravity, an endless belt of steel plates or trays, running the whole length of the jib, driven by means of a friction clutch on the main shaft in the tower, delivers the coal to the ship's hold or bunker. The entire apparatus is under the control of an operator in the tower. The belt conveyor is driven by a Westinghouse shunt-wound direct current motor, run at a speed of 750 revolutions per minute with a voltage of 400. The installation, with the exception of electric motors, was constructed by Spencer & Company, Ltd., Engineers, Melksham, Wilts. 4 illustrations. 1,300 words.—*The Engineer*, September 26.

The Fottinger Transmitter.—An article giving complete data regarding a temporary plant installed at the Vulcan Works, Hamburg, for a long duration test of a 10,000-horsepower Föttinger transmitter, which was built with a view to fitting an installation of this power into a ship being built at the Vulcan Yard for service on the South Atlantic and through the Panama Canal. The main feature of the machine tested, which is fully illustrated, is the provision of a distinct water circuit for each of the two directions of rotation of the propeller shaft. The whole of the machine is mounted in one single casing, separated into two parts by a hollow partition. A very complete description of the machine is given and the method of operation is explained. After pointing out the main advantages of this type of transmission gear, the question of leakage losses is carefully dealt with. Other items of interest discussed are the governor and control gear and the methods of maneuvering. The maximum power recorded during the test of this plant was over 10,000 shaft horsepower. The reduction ratio corresponding to the highest transformer efficiency in all the tests was in the neighborhood of 1 to 5.3. The highest efficiency in almost every case was nearly 90 percent when going ahead and 70 percent when going astern. The excellent results obtained in these tests and the satisfactory condition of the transformer after the tests were made, led to the final ordering from the Vulcan Company of a machine of this type for a 22,000 ton steamer. 20 illustrations. 5,250 words.—*Engineering*, August 15.

The Cargo Ship France.—The vessel described is a combined sailing and oil engine-driven cargo boat built recently by the Société Anonyme des Chantiers et Ateliers de la Gironde, Bordeaux, for the Société des Navires Mixtes, of Rouen, for service between France and New Caledonia. She is a five-masted ship with 70,000 square feet sail area and is fitted with two Schneider Carels-Diesel oil engines of 900 shaft horsepower designed for a speed of ten knots. The extreme length of the vessel is 430 feet; the beam, 55 feet 9 inches; the depth, 28 feet 2 inches; the draft, loaded, 23 feet 11 inches; the displacement, loaded, 10,700 tons; and the cargo carrying capacity, 6,500 tons. The ship is built of steel throughout and has a forecastle, a long deckhouse amidships and an after deckhouse. Her lower deck and holds are divided for the storage of goods. The double bottom, extending the whole length, is arranged for carrying water ballast. The deckhouse amidships has accommodations for six first class passengers. The after house is reserved for the ship's officers. The construction of the Diesel engines, fitted in the ship, is described in detail and data are given showing the results obtained on trial. The cylinders of the engines, which are of the four cylinder two cycle type, are 17.716 inches diameter with a stroke of 22.047 inches. The total weight of the engines, including shafting, flooring and auxiliary apparatus, works out at 158 pounds per shaft horsepower. The engines are uncoupled from the propeller shafts when the ship is under sail. During a six-hour trial on the testing bed at the works, each engine developed 925 shaft horsepower on a speed of 234 revolutions per minute. The fuel consumption on trial was .329 pound per indicated horsepower hour and .462 pound per shaft horsepower hour. 20 illustrations. 1,900 words.—*Engineering*, October 10.

The Large Canadian Lake Steamer James Carruthers.—The largest vessel of any description yet constructed in Canada is the bulk freighter *James Carruthers* built for the St. Lawrence and Chicago Steam Navigation Company, Ltd., of Toronto, by the Collingwood Shipbuilding Company of Collingwood, Ontario. The vessel is of the single deck type, designed for the transport of bulk cargoes of coal, ore and grain. The hull is 550 feet, 8 inches long over all, 58 feet molded beam and 31 feet molded depth. The deadweight capacity is 10,000 tons and load draft 19 feet. In accordance with the usual design of Great Lake freighters, no loading or discharging appliances are provided on board the ship. The cargo is handled through 31 hatchways spaced 12 feet apart center to center, each 38 feet wide and 9 feet long. Two complete collision bulkheads are fitted forward, forming a deep tank. The cargo hold is divided by screen bulkheads into six compartments and the double bottom by four watertight divisions into five compartments for water ballast. The remaining bulkheads are a cross bunker screen bulkhead between the engines and boilers, which are placed aft and a watertight after peak bulkhead. The upper deck stringer and plating between the hatch and the ship's sides is supported by longitudinal channel girders instead of transverse beams, which is a new feature on a vessel framed on the transverse system. The article describes the deck and auxiliary machinery in some detail. The propelling machinery, built by the Collingwood Shipbuilding Company, consists of a single set of triple expansion reciprocating engines with cylinders 24, 40 and 66 inches diameter by 24 inches stroke, capable of developing 2,400 indicated horsepower, which is designed to give the ship a speed of 11 miles per hour when loaded and 13 miles per hour in light condition. Steam is supplied by three Scotch boilers 15 feet in diameter and 12 feet long, designed for a working pressure of 185 pounds per square inch, and operated under Howden's system of forced draft. Construction of the vessel was begun in September, 1912, she was launched May 22, 1913, and went into commission in June. The article is well illustrated with excellent photographs of the vessel, showing the different stages of construction and launching. 11 illustrations. 1,700 words.—*The Shipbuilder*, October.

The Electric Motor Ship Tynemount.—The Electric motor ship *Tynemount*, built by Swan, Hunter & Wigham Richardson, Ltd., of Wallsend for the Electric Marine Propulsion Company, Ltd., recently underwent satisfactory trials, and is now ready for service on the canals and Great Lakes of North America. The boat is 250 feet long, 42 feet 6 inches beam, 19 feet molded depth She is of conventional lake design with the machinery aft. The prime movers are two six-cylinder Diesel engines of four cycle type each designed to develop 300 brake horsepower at a speed of 400 revolutions per minute. The cylinders are 12 inches diameter and 13½ inches stroke. They differ in no respect from the general type of engines made by Mirrlees, Bickerton & Day of Hazel Grove, near Stockport. Although the two engines are identical, the generators coupled to the engines differ in that one generator has six poles and the other eight poles, the periodicity of the current from the former being 20 per second, while that of the current from the latter is 26.6 cycles. Both generators have an output of 270 amperes per phase at 500 volts, which absorbs the full power of the engines, and they both run at the same speed; that is, 400 revolutions per minute. An exciter is coupled on the shaft of each alternator, and is designed to give an exciting current of 30 amperes, which can, when necessary for maneuvering purposes, be increased up to 50 amperes. Both alternators can be connected to a special type of induction motor patented by Messrs. Mavor & Coulson, which has two field windings entirely separate from each other, one embracing 30 poles and the other 40 poles. When these two windings are supplied with current at 20 and 26.6 periods respectively, they give the same synchronous speed of 80 revolutions per minute. Under these conditions, the motor will absorb the full power of both engines and drive the propeller to which its rotor is directly connected at a speed of 78 revolutions per minute, which corresponds to the fastest speed of the vessel. To obtain a slower speed, the connections are altered so that the alternator giving a 20-period current supplies the 40-pole winding of the motor, while the other alternator is disconnected and shut down. The result is that the synchronous speed of the motor driving the propeller is reduced to 60, and only about half the full power is developed. The direction of rotation of the motor is readily reversed by interchanging the connection of the two phases. This system overcomes the difficulty of attempting to run the two alternators in parallel. The whole handling of the ship can be carried out by means of two levers which are so interlocked that they are claimed to be practically "fool-proof." The controlling apparatus is explained in detail. 11 illustrations. 2,700 words.—*The Engineer*, October 10.

The Story of the Leyland Line.—At the end of the year 1912, the fleet of the Leyland line consisted of forty-five vessels of 275,300 tons, and there were under construction nine additional vessels of 52,275 tons. There are five passenger services maintained by the Leyland line, and on all of them cabin passengers only are carried. The various routes are from Liverpool to Boston; from London, Liverpool and Antwerp to New Orleans; from Liverpool to Jamaica, Mexico and Tampico; from Liverpool to St. Thomas, Colombia and the Isthmus of Panama, and from Liverpool to Barbadoes, Trinidad, Curacoa and intermediate places. This immense and varied service is the result of a continual growth of the line since its inception in the fifties of the last century. Mr. Bibby, of the well-known Liverpool shipping firm, established the line with a service to the Mediterranean. From this beginning the growth of the line, with its many alliances with other steamship companies at the various ports in the North Atlantic trade, is traced in an interesting manner by the author of the article. Reference is also made to the famous shipyards in which the vessels of the fleet were built, and particularly to the Harland & Wolf shipyard of Belfast, which was founded soon after the Bibby line was established and from which many Leyland line vessels were launched.—2,600 words.—*The Marine Engineer and Naval Architect*, October.

ENGINEERING SPECIALTIES

New Type of Condensing Turbine

Two main objects were sought in the design of the latest type of condensing turbine, manufactured by the Terry Steam Turbine Company, Hartford, Conn., namely, an economy approaching that of the larger units used in power installations and the prevention of air leakage into the condenser. In the new turbine the only gland exposed to vacuum has been shifted from the end of the casing to the middle, where it is exposed on one side to vacuum and on the other to steam at just above atmospheric pressure, thus making a leakage of air through this gland a physical impossibility. With this arrangement packing, or other devices, are unnecessary to keep the air out of the turbine.

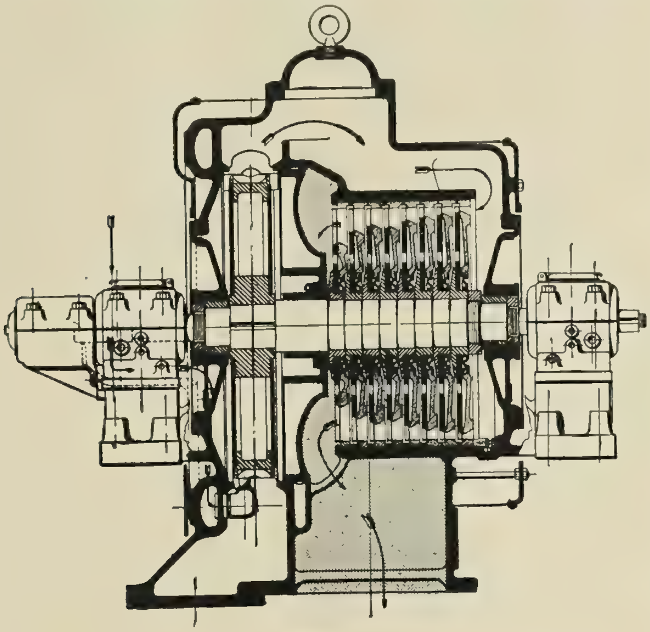


FIG. 1

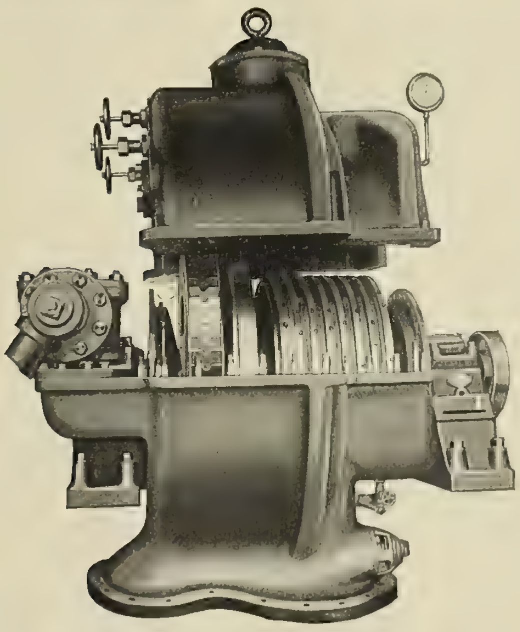


FIG. 2

The machine consists essentially of a regular Terry multi-velocity wheel as the high-pressure element, and a low-pressure end consisting of several multi-pressure impulse elements. The main feature distinguishing the arrangement of this low-pressure element from that used in some other types lies in the fact that it has been turned end for end, receiving steam at the end farthest from the high-pressure element and exhausting into the condenser connection at the center of the turbine. By this simple device of reversing the flow of steam and thus protecting the vacuum gland the old trouble of air leakage has been eliminated.

This turbine has the regular Terry characteristics, including a casing split on the axial plane, permitting examination of the runner without disturbing either steam or exhaust connections. It has the Terry indestructible high-pressure element which permits starting up the turbine from cold, even though a large quantity of water is thus thrown through the blades. This, the manufacturers claim, is done regularly without any danger from water hammer or any apprehension as to stripping of blades.

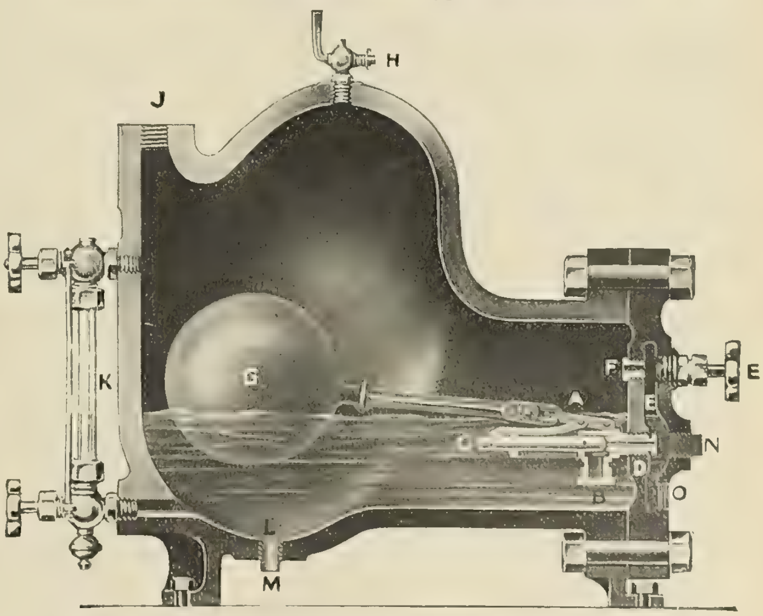
The stationary buckets in the low-pressure end are placed on annular rings, from which they may be removed in blocks as necessary. These rings are not fastened to the casing, but are bolted together and remain with the runner when the casing is removed, as can be seen in Fig. 2. They are held by friction to the casing when the upper half is drawn down tight to the lower half, and hence always retain their position when the turbine is running. This arrangement makes it very simple to examine all parts with a minimum of trouble.

The method of swinging the casing from the bearing blocks instead of from the base makes it always concentric with the runner. Expansion is radial and all clearances are maintained practically the same when the turbine is running as when it is cold. The side of the bearing in the pillow block is cylindrical. This is bored at the same time as the casing and from the same center, so that the axis of the runner cannot get out of line with the axis of the casing.

This new design of turbine is being applied to three principal uses—driving electric generators, blowers and centrifugal pumps; and up to date more than 300 Terry turbines have been installed in the United States and British navies for these purposes.

American Ideal Steam Trap

The American "Ideal" steam trap, manufactured by the American Steam Gauge & Valve Manufacturing Company, Boston, Mass., is of the ball-float type, but differs from other



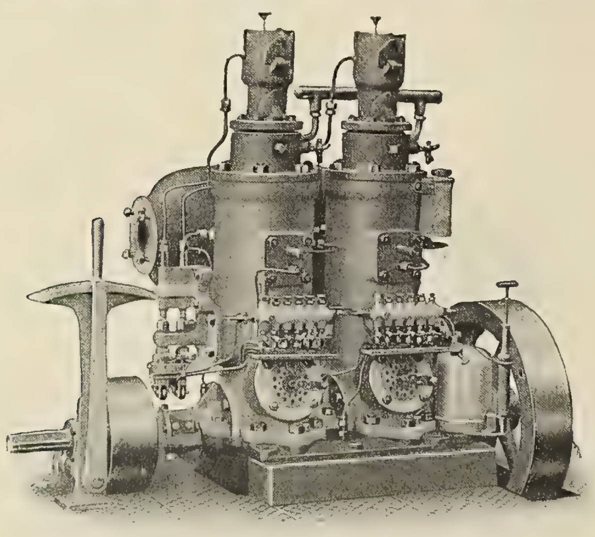
steam traps of this type in that its operation is not materially affected by the motion of the ship. The construction is such that the trap may tilt to an angle of 35 degrees either way without affecting its operation. A horizontal valve guided true to its seat by two bearings is fitted with an adjustable seat which can be regulated to give the valve a sufficient amount of water seal so that the valve will not be exposed to the steam at any angle of the ship. This is accomplished by the use of a specially designed shell large enough to maintain enough water in the trap to keep the valve sealed at all angles, and by the use of a heavy float which is not so easily affected by motion as a lighter float. This construction, it is claimed, overcomes the faults in other types of steam traps, whose successful operation depends almost wholly upon being in a horizontal position at all times, on account of the use of centrally and vertically guided valves or balance weights.

Practically all steam traps are constructed with a system of leverage which determines the capacity of the trap and the weight of the float which can be used to operate the valve. Where the leverage is insufficient, pilot valves and balance weights are used to aid in operating the valve proper. Such conditions, however, are eliminated in the American "Ideal" trap on account of a specially designed system of leverage which is exceptionally powerful, and which with the use of heavy floats makes possible the construction of a steam trap of great capacity. There is an emergency by-pass in the cover which does not affect the water seal, and also a water gage which is the "watchman" for all steam traps.

The actual capacity of any steam trap is obviously limited to the size of the opening in the valve seat. The American "Ideal" traps have standard size orifices in the valve seats equal to the pipe size connections, therefore giving assurance that the valve is large enough to handle all the condensation coming to it through the inlet pipe. By specifying the size of orifice in the valve seat and the maximum pressure under which the trap must operate, the manufacturers claim that all guesswork in determining the proper size of trap is eliminated, as the American "Ideal" trap is built to meet these specifications.

The "Original" Crude Oil Semi-Diesel Motor

The "Original" motor, manufactured by Bergsunds Mek., Verkstads A. B., Stockholm, is a semi-Diesel engine working on the two-cycle principle, but it differs in many respects from the numerous semi-Diesel engines at present on the market. In the first place, there is no hot bulb for ignition. In place of



this there is a separate water-cooled combustion chamber in which there is a nickel steel grid plate set at an angle to atomize the fuel. This plate is so arranged that it can be easily removed simply by taking out two small screws which connect it to the top cover plate. The fuel is spread on to the grid in a circle, an arrangement which, combined with the angle at which the grid is set, results, it is claimed, in the immediate vaporization or combustion of the heavy oil. It is claimed that there is no carbon deposit, and as freedom from carbon means perfect combustion and low fuel consumption the economy of the engine is apparent.

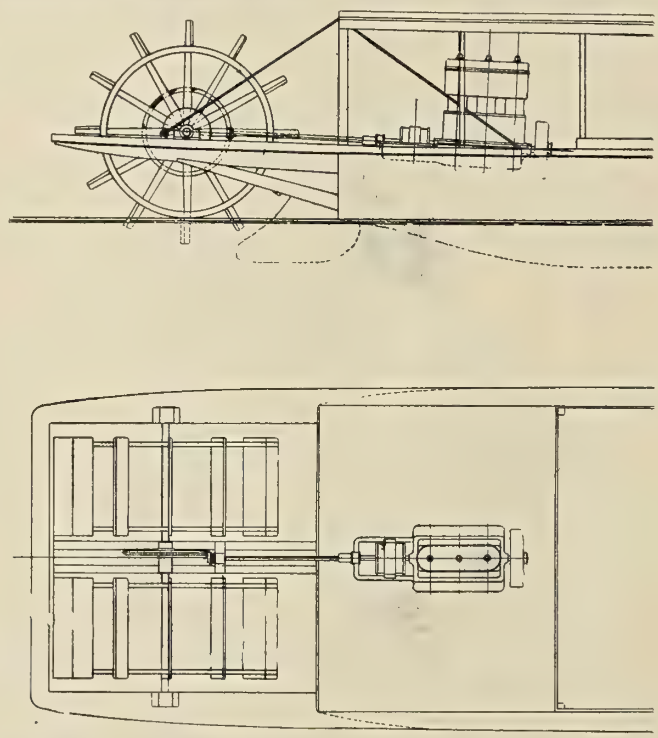
To start the engine, the grid plate described above is heated through contact with the top cover plate by a blow lamp, which is extinguished after the engine is started. The heat of combustion, it is claimed, always keeps the plates at the required temperature whether the engine is running with a light or full load. On account of this patent ignition the makers find it unnecessary to fit a water drip, and a troublesome accessory is thus entirely dispensed with.

The "Original" motor is fitted throughout with forced lubrication to all parts, including the gudgeon pin bearings, and the amount of oil supplied is determined by the speed of the engine. Ignition is effected not on the hit-and-miss principle, but by a variable fuel supply, which, it is claimed, insures an economic use of the fuel, as the amount of fuel used is supplied strictly in accordance with the load on the engine. This method of governing also allows the engine to be run light indefinitely without the use of a blow lamp. Crank case compression is maintained by a patent collar, which works in a groove and is a tight fit on the shaft.

These motors are constructed in sizes from 5 to 300 brake-horsepower, with from one to four cylinders. The smaller sizes are furnished with mechanical reversing gear and the larger sizes are directly reversible by compressed air. The sole representatives for the manufacturers of these engines for the United Kingdom and China are Messrs. R. Wilson & Sons, Bank Chambers, Laygate Circus, South Shields.

Stern Wheel Motor Drive

A novel method of driving a paddle-wheel on a stern-wheel, shallow-draft boat by a gasolene (petrol) engine has been devised by the Standard Motor Construction Company, Jersey

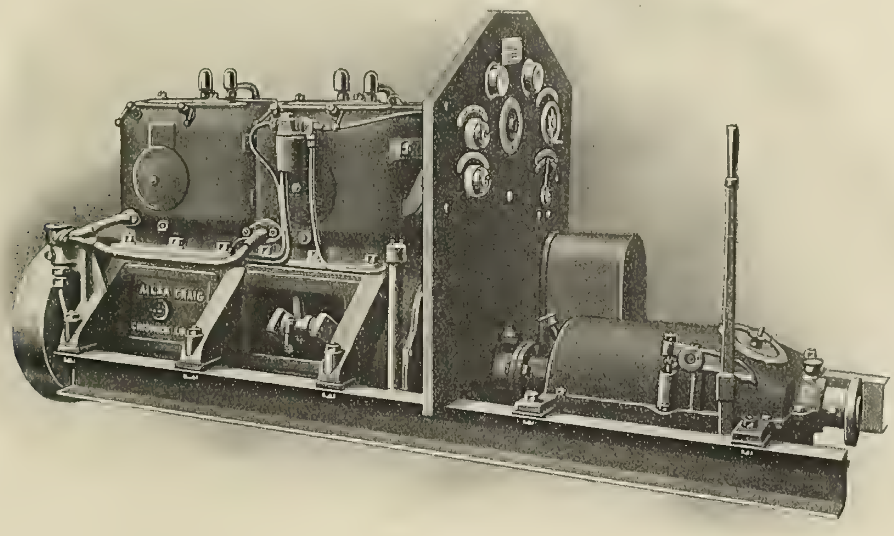


City, N. J. As shown in the illustration, the engine is direct connected to the wheel shaft by bevel gears, thus eliminating belts, cross shafts, etc. The engine can be placed in a fore-and-aft position on the center line of the boat, and, by a proper selection of gears, the most advantageous speeds of both engine and wheel can be obtained. This scheme is also commended by the simplicity and cheapness of its construction.

Ailsa Craig Marine Motors

The illustration shows a view of the port side of a 35-horsepower Ailsa Craig marine motor, manufactured by the Ailsa Craig Motor Company, Ltd., Chiswick, London, W. This is a four-cylinder, four-cycle engine, with cylinders 5 inches diameter and 5½ inches stroke, which, at from 700 to 950 revolutions per minute, develops from 30 to 35 brake horsepower, the fuel consumption being about three-quarter pint per horsepower per hour.

One of the most distinctive features in the design of the Ailsa Craig motors is the offset cylinder, which is set slightly in advance of the crank shaft, so that at the moment of maximum effort of the working stroke the connecting rod is practically vertical and parallel with the sides of the cylinder, giving a direct thrust from the piston to the crank shaft without side thrust on the cylinder walls. A mechanical advantage is also gained at the end of the compression stroke, and owing to the piston speed being reduced when passing the dead center the exhaust gases have a longer time in which to escape than is possible in the ordinary engine. These special features of design result, it is claimed, in a gain in power and flexibility, besides insuring a remarkably smooth and silent-running engine. The motors can be operated on gasoline (petrol) or kerosene (paraffin), and the vaporizers are arranged so that the heat can be regulated to give the best results with fuel up to 150 degrees flash point.



The material used in the construction of these motors is of high grade throughout; the cylinders are of fine-grain hard iron cast integral with water jackets, which are exceptionally large and extend completely around the cylinders and valve pockets. The crank shafts are forged from solid high tensile steel billets and machined all over. The pins are ground true to 1/1000 inch. The valves are interchangeable and mechanically operated from a single cam shaft. The valve plungers, guides and springs are entirely inclosed in a metal casing, completely protecting them from dampness or mechanical damage. Oil for lubrication is pumped under pressure direct to every bearing, passing up the connecting rods to the gudgeon pins and ignition is by a high-tension magneto, direct driven.

Growth of Traffic on the Rhine.—According to the annual report of the German Rhine Navigation Commission for the year 1912, the total traffic on the German Rhine for 1912 was 61,189,316 metric tons of freight, or 6,967,164 tons more than in 1911. The percentage of increase was 13 and was the highest on record and very likely will never be equaled again. The growth of Rhine traffic is attributed to a general increase of business in 1912, but is more especially due to the improvements made in the river channel during 1911 and previous years, which has made the stream navigable as far as Kehl at practically all seasons of the year and permits of the use of deeper draft vessels. It is a matter of interest that the freight steamers and barges on the Rhine are largely constructed from American plates.

Obituary

John V. van Santvoord, one of the principal owners of the Hudson River Day Line, New York, died suddenly at Lake Mohonk on Sept. 26. Mr. van Santvoord was a son of the late Commodore Cornelius, who established the Hudson River Day Line, and he was also a grandson of the man who operated the first passenger-carrying line on the Hudson, known as the "Swift and Sure Line."

William Cary Selden, consulting engineer for the Clyde and Mallory Steamship lines, died at his home in Brooklyn on Sept. 24, aged eighty-one years. Mr. Selden entered the navy in 1857 and retired in 1868 with the rank of first assistant engineer. Mr. Selden was recognized as an expert in marine engineering. For many years he was designer of steam vessels and, until 1912, was the active superintending engineer of the Clyde and the Mallory lines.

Dr. Rudolph Diesel, inventor of the internal combustion engine, which bears his name, disappeared from an English Channel steamer Sept. 29 while on his way from Antwerp to Harwich to attend a meeting of the Diesel Company in London. As far as can be ascertained, Dr. Diesel fell overboard from the steamer and was drowned. Rudolph Diesel was born in Paris in 1858, and was educated in Augsburg, Germany, and at the Polyclinic College, Munich.

Personal

B. F. Davis was recently promoted to the position of chief engineer on the steamship *Olivette*. This promotion is well deserved, as Mr. Davis has served faithfully in all grades in the engine room on board ship, starting as an oiler on the very same ship of which he is now chief engineer. Mr. Davis also previously had a thorough training on the technical side of engineering in the old schoolship *Enterprise*.

STATEMENT OF THE OWNERSHIP, MANAGEMENT, CIRCULATION, ETC., of International Marine Engineering, published monthly at New York, N. Y., required by the Act of August 24, 1912.
Editor, H. H. Brown; managing editor, H. L. Aldrich; business manager, H. L. Aldrich; Publisher, Aldrich Publishing Company, all of 17 Battery Place, New York.
Owners, H. L. Aldrich and M. G. Aldrich, both of 17 Battery Place, New York.
Known bondholders, mortgagees, and other security holders, holding 1 per cent or more of total amount of bonds, mortgages, or other securities, A. I. Aldrich, Manville, R. I.; J. W. Reno, New York, N. Y.; Geo. Slate, Summit, N. J.; E. L. Sumner, Flushing, N. Y.
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President and Treasurer Aldrich Publishing Company.
Sworn to and subscribed before me this 13th day of September, 1913.
O. M. Pickruhl, Notary Public.
(My commission expires March 30, 1915.)

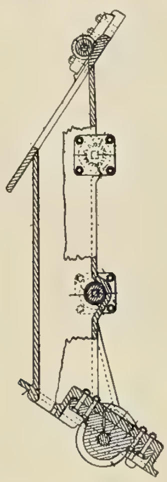
SELECTED MARINE PATENTS

The publication in this column of a patent specification does not necessarily imply editorial commendation.

American patents compiled by Delbert H. Decker, Esq., registered patent attorney, Loan & Trust Building, Washington, D. C.

1,067,872. SHIP'S HAWSE-PIPE. ALBERT HAMILTON, RICHARD HAMILTON, AND ALBERT HAMILTON, JR., OF CARDIFF, WALES.

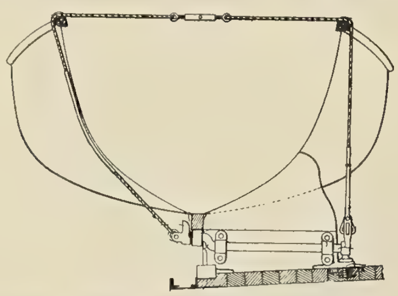
Claim 1.—In a ship's hawse-pipe, flanged bosses protuding inwardly through flanged lateral holes within the length of said hawse-pipe, a



transverse spindle journaled in said flanged bosses and a transverse roller mounted on said spindle. Four claims.

1,071,765. DEVICE FOR SECURING AND RELEASING LIFEBOATS. ANDREAS P. LUNDIN, OF NEW YORK, N. Y., ASSIGNOR, BY MESNE ASSIGNMENTS, TO ASTOR TRUST COMPANY, TRUSTEE, A CORPORATION OF NEW YORK.

Claim 2.—In devices for securing and releasing lifeboats, the combination with a cradle for the inboard side of such boat, a chocking block



for the outboard side movable relatively to said cradle, a grip chain secured to said chocking block and adopted to be released by the movement thereof, and means for moving said chocking block. Four claims.

1,071,735. ICE-BREAKING MARINE VESSEL. BENJAMIN T. HAAGENSON, OF ASHTABULA, OHIO.

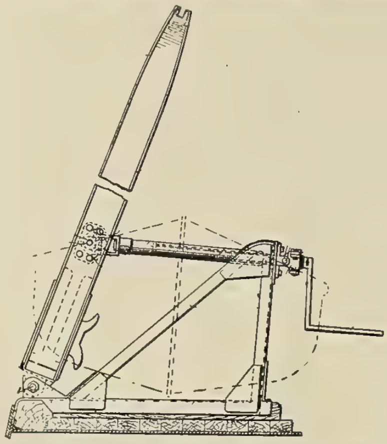
Claim 1.—The combination, with a marine vessel, of controllable means operating on opposite sides of the keel or medial line for imparting a rocking or oscillating movement to said vessel, and mechanism whereby said means is caused to reverse the direction of its action upon the vessel at regular and predetermined intervals of time. Six claims.

1,071,393. BUOY FOR SUBMARINE BOATS. DANIEL L. CAYO OF WOOSTER, OHIO.

Claim 1.—The combination with a submarine vessel, having a cradle formed in its upper surface, of a buoy provided with a frame, a hollow reel mounted in said frame, a hollow stationary hub carried by the frame and upon which an end portion of said reel is mounted, a cable adapted to be secured at one end to the submarine vessel and passing into said hollow reel and out through said hub and thence upwardly to the top of the buoy and suitable electrical conductors arranged within said cable. Two claims.

1,071,783. BOAT DAVIT. HAROLD FREDERICK NORTON OF NEWPORT NEWS, VA.

Claim 1.—A davit supported by a pivot at its lower end, and means for oscillating said davit comprising two substantially horizontal members con-

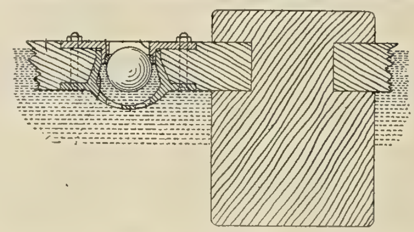


nected by a nut and long screw, one member being non-revoluble and directly swiveled to said davit intermediate its ends, the other member being revoluble, and a fixed deck-stool having a bearing swiveled for universal movement in which said revoluble member is thrust-journaled, its outer end extending through the bearing and provided with means for effecting rotation. Five claims.

British patents compiled by G. E. Redfern & Company, chartered patent agents and engineers, 15 South street, Finsbury, E. C., and 21 Southampton Building, W. C., London.

20,482-1912. IMPROVEMENTS IN BOAT PLUGS. H. R. HOWE, OF SMITHDOWN ROAD, LIVERPOOL.

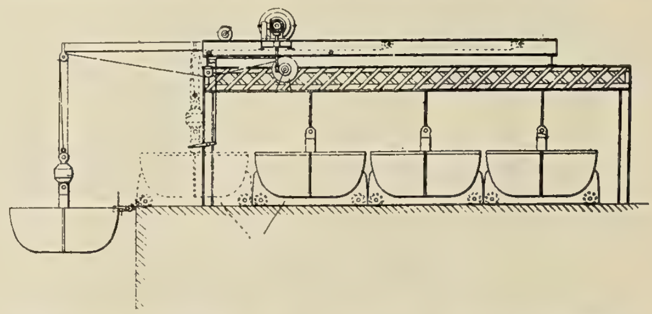
Claim.—An improved automatic plug device for ships' boats comprises a valve chamber formed of two plates adapted to be clamped to the boat bottom, and provided with a sleeve on one plate spigoted into a hollow



socket on the other; the socket is made taper for part of its length and with parallel sides for the remainder, while the sleeve has a waterway through it with parallel sides so as to receive an ordinary plug when required, and has at its extreme end a valve seat against which a spherical valve automatically seats itself when raised by the pressure of water.

18,339-1912. LAUNCHING BOATS AND THE LIKE FROM SHIPS. W. D. KEY OF CAMBERWELL GATE, LONDON.

Claim.—This invention relates broadly to appliances for launching boats from ships in which the lowering tackle is carried upon horizontal sliding arms mounted in guides on a framework upon the deck of the vessel and adapted to be projected beyond the sides of the vessel when



required for launching the boats. Each boat is launched by being projected from the end of the arm which is then projected beyond the side of the vessel, the arms and lowering tackle both being operated from a single stationary motor.

1,071,835. LIFEBOAT. CHARLES WILLIAM WALLIS OF TORONTO, ONTARIO, CANADA.

Claim 1.—In a nested boat, opposing seats comprising arc-shaped brackets pivotally connected at their lower end to the inside of the boat and adapted to fold against and fit the inside of the boat, flexible seats secured at one end to the side of the boat and at the opposite end to the top of the brackets, and means for securing the opposing brackets together. Two claims.

International Marine Engineering

Published Monthly by ALDRICH PUBLISHING CO.

17 BATTERY PLACE, NEW YORK — 31 CHRISTOPHER ST., LONDON, E. C.

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Vol. XVIII — DECEMBER, 1913 — No. 12

Five-Masted Auxiliary Sailing Ship France

BY F. C. COLEMAN

One of the most interesting vessels built in any part of the world during the present year (1913) is the auxiliary sailing ship *France*, constructed by Chantiers et Ateliers de la Gironde, of Bordeaux, for the Société des Navires Mixtes, of Rouen. The *France* is a five-masted ship, and is the largest sailing ship fitted with auxiliary motive power which has yet been built. The principal dimensions are:

FIG. 1.—SAILING SHIP FRANCE FITTED WITH SCHNEIDER-DIESEL ENGINES

Extreme length	430 feet
Beam	55 feet 9 inches
Depth	28 feet 2 inches
Draft loaded	23 feet 11 inches
Displacement loaded	10,730 tons
Capacity of holds	353,000 cubic feet
Carrying capacity	6,500 tons
Sail area	70,000 square feet

Built of steel throughout, to both the Bureau Veritas and Lloyd's specifications, the vessel has a forecastle, a long deck-house amidships, and an aft deck-house. Her lower deck and holds are divided for the storage of goods, while the double bottom over the whole length is arranged for carrying water ballast. There are also a fore peak and a large water tank to ensure her stability when light.

The deck-house amidships is fitted up for berthing six first class passengers and a doctor. The accommodation comprises the necesary cabins, a saloon, smoke room, reading room, photographic dark room and bathrooms, heated by steam and electrically lighted. The house aft contains the cabins for the ship's officers.

Propelling Machinery

The propelling machinery, built at Messrs. Schneider's Creusot Works, consists of two Schneider-Carels four-cylinder two-cycle internal combustion engines having cylinders 17.716 inches in diameter with a 22.947-inch stroke. During a six-hour trial on the testing-bed at the works each engine developed 925 shaft horsepower at a speed of 234 revolutions per minute. The engine-room is right aft, and each engine drives a propeller by a short shaft; the shafts are uncoupled from the engines when the ship proceeds under sail.

Details of the engines are shown in Figs. 5-8. Besides the four working cylinders, each engine has an air-compressor for fuel injection, a scavenging pump, a cooling water pump and lubricating pumps, whose speed is half the main-engine speed.

Engine Construction

The working cylinders have independent liners, and are bolted on a cast iron frame. This forms a closed-in casing, which is provided with large inspection doors, and is bolted down upon the base plate, the latter being fixed to the keelson. Inside the frame, and underneath each cylinder, are provided guards, which allow the free travel of the connecting rod, but prevent the lubricating oil from penetrating the cylinders.

The cylinder heads are steel castings; each head is fitted with four scavenging valves, one needle fuel valve, one starting valve, and one small safety valve. The pistons are of cast iron in two parts; two of the connecting parts are hollow, and form a passage for the circulation of the oil for cooling the pistons. Besides the rings at the top end of each piston, there are two at the lower end to prevent the escape of burnt gases inside the engine frame.

The gear is operated by two shafts on the side of the engine frame. One of these, a lay shaft, driven by the engine and having the same speed as the latter, is fitted with cams for running ahead and running astern. The second shaft, a weigh shaft, located above the former, has only one set of cams; it can be operated by hand by means of a hand wheel, and serves to regulate the phases of the distribution.

The scavenging valves are operated two by two by levers driven by rods. The latter are each connected to a second lever, which is operated in the middle of its length by a cam of the lay shaft, the fulcrum being on a vertical rod having at its top part a roller, which bears constantly against a corresponding cam on the weigh shaft. Since the fuel and starting valves do not work simultaneously, they are operated by the same lever and one single rod; the fuel valve opens upwards and the starting valve downwards. Two levers, situated below and above the lay shaft, are joined on the lower end of the rods; the fulcrum of both these levers is on the same bar, which is guided in its action and is provided at its end with a roller which bears against a grooved cam on the weigh shaft.

FIG. 2.—PASSENGER SALOON ON THE AUXILIARY SAILING SHIP FRANCE

Maneuvering

Starting is by compressed air. The weigh shaft is first revolved, and placed in such a position that the rollers of the lower levers of the scavenging and starting valves are in contact with their respective cams for running ahead, the starting valves open, and the air coming from the receivers for starting causes the engine to turn. When the engine has reached a sufficient speed the weigh shaft is operated so that, two cylinders remaining supplied with compressed air, fuel is injected in the two others; when the latter operate normally, fuel is injected in all four cylinders. The fuel supply is then regulated to give the engine its required speed.

Reversing is effected by a longitudinal displacement of the lay shaft, which brings the cams for running astern in the place previously occupied by those for running ahead; this can only be carried out when the weigh shaft is in a neutral position. When the position of the cams has thus been shifted the engine is started in the same way as obtains for running ahead. Reversing, requiring only the maneuvering of a hand wheel and a lever, is effected in a few seconds, and with a moderate consumption of compressed air.

Pumps

The fuel is supplied to the fuel valves by four independent pumps, each of which can be cut out simply by closing the fuel supply cock. When running, the fuel consumption is regulated in the usual way by acting upon the suction valve. This valve is also under the action of the governor, which decreases the flow of the fuel gradually as the speed exceeds 230 revolutions per minute. It is open when starting on compressed air.

The scavenging pump, driven by the crankshaft, draws from the engine room, through a pipe provided with a screen, and

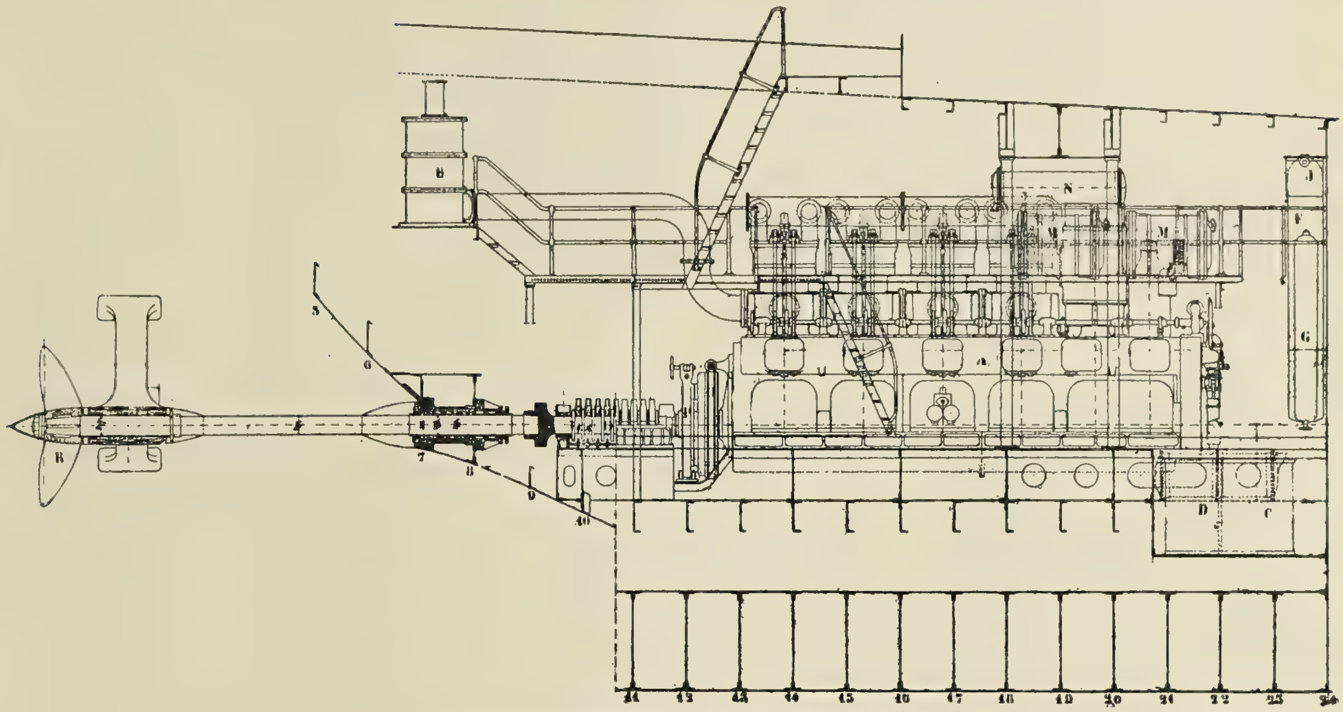
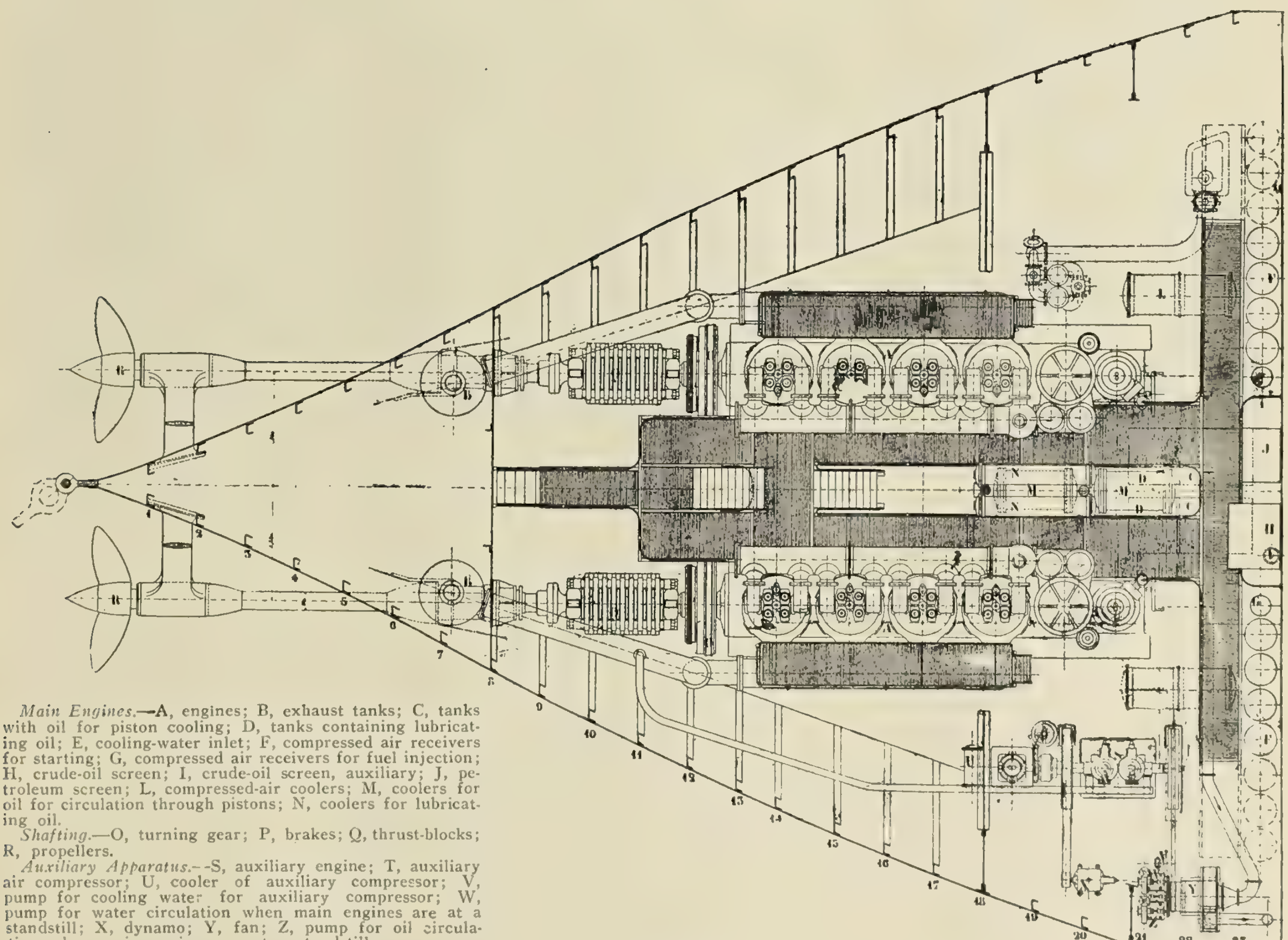


FIG. 3.—LONGITUDINAL SECTION THROUGH ENGINE ROOM



Main Engines.—A, engines; B, exhaust tanks; C, tanks with oil for piston cooling; D, tanks containing lubricating oil; E, cooling-water inlet; F, compressed air receivers for starting; G, compressed air receivers for fuel injection; H, crude-oil screen; I, crude-oil screen, auxiliary; J, petroleum screen; L, compressed-air coolers; M, coolers for oil for circulation through pistons; N, coolers for lubricating oil.

Shafting.—O, turning gear; P, brakes; Q, thrust-blocks; R, propellers.

Auxiliary Apparatus.—S, auxiliary engine; T, auxiliary air compressor; U, cooler of auxiliary compressor; V, pump for cooling water for auxiliary compressor; W, pump for water circulation when main engines are at a standstill; X, dynamo; Y, fan; Z, pump for oil circulation when main engines are at a standstill.

FIG. 4.—PLAN OF ENGINE ROOM

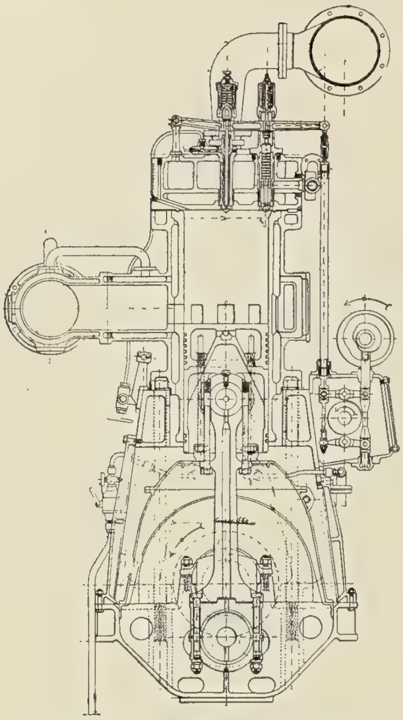


FIG. 5.—SECTION THROUGH WORKING CYLINDER

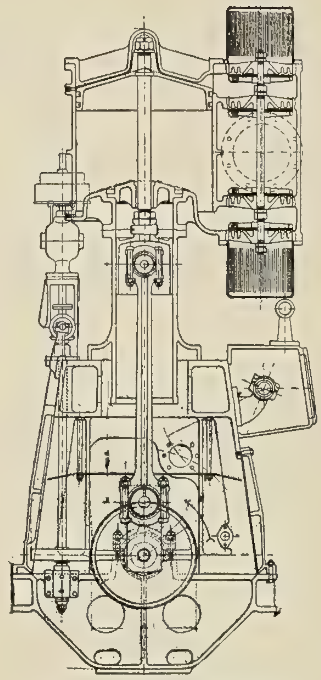


FIG. 6.—LOW-PRESSURE STAGE OF AIR COMPRESSOR

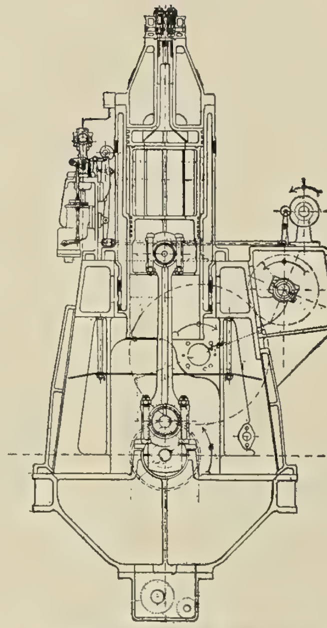


FIG. 7.—HIGH-PRESSURE STAGES OF AIR COMPRESSOR

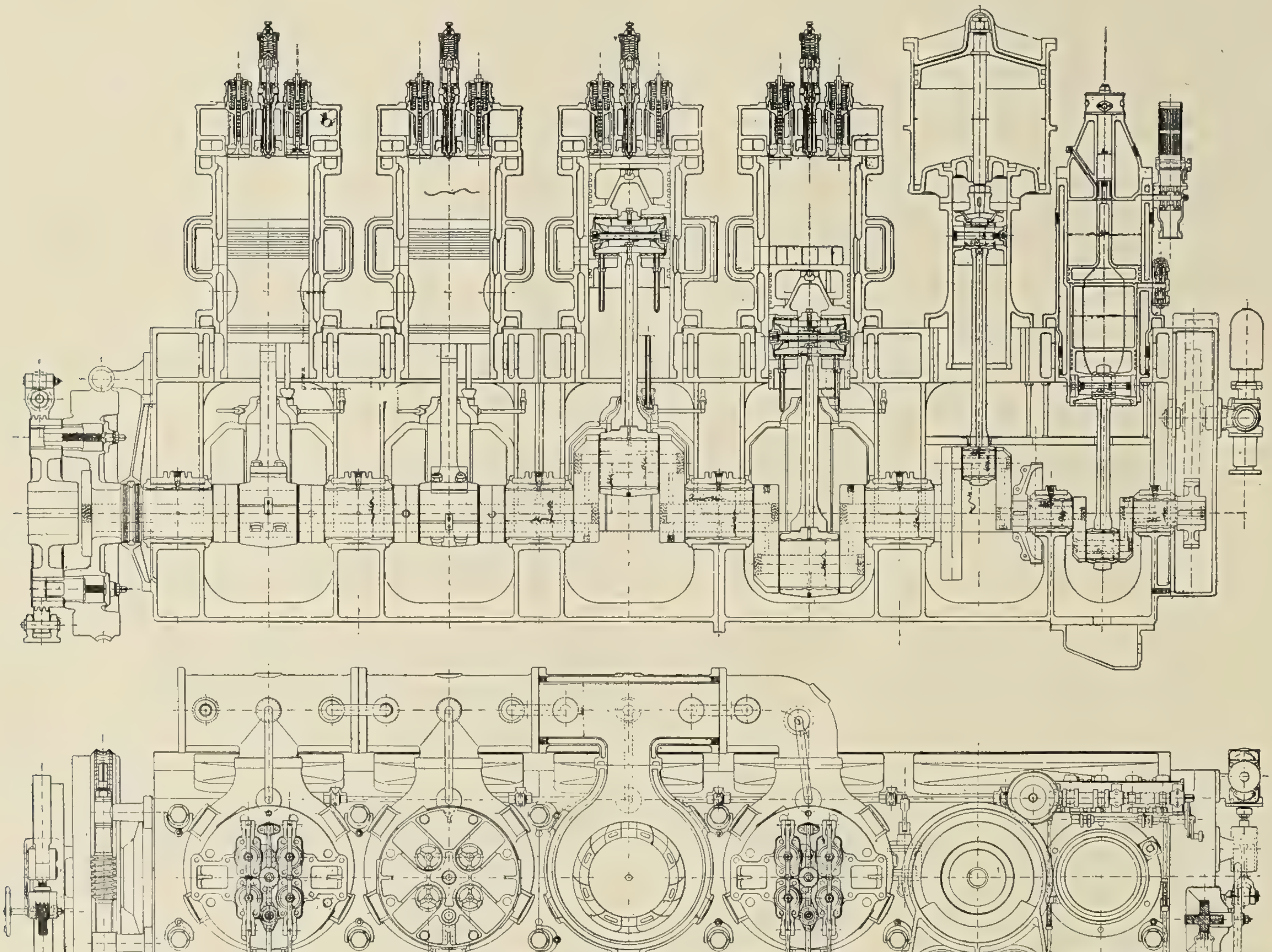


FIG. 8.—900 SHAFT HORSEPOWER SCHNEIDER-DIESEL ENGINE FOR THE FRANCE

delivers into a large capacity receiver at a pressure which varies from 2.8 pounds to 4.9 pounds per square inch, according to the speed of the engine. Suction and delivery take place through Hoerbiger metallic valves, which act satisfactorily, notwithstanding the comparatively high speed of the engine.

The air compressor for fuel injection is also driven by the crank shaft; this is a three-stage compressor, and each stage is water-cooled. The air supply to the low-stage cylinder is provided with a butterfly valve, the position of which is regulated according to the pressure required for the fuel delivery. It is opened out completely when the compressor acts at the same time for charging the compressed-air receivers for starting.

containing the lubricating oil and delivers through sight-feed lubricators at two opposite points of the piston circumference.

The water circulating pump draws from the sea through a double screen, which can be inspected while the engines are running. The water flows first through the air-cooler, and is then delivered to the two coolers for the lubricating oil and the circulating oil for cooling the pistons; it then circulates round the air compressor for fuel injection, the cylinder ends, and then runs back to the sea. The water is taken from one of the cylinder heads for heating the oil fuel by means of a coil placed in the oil fuel tank.

Fuel Supply

A set of cocks on the suction side of the pumps allows the

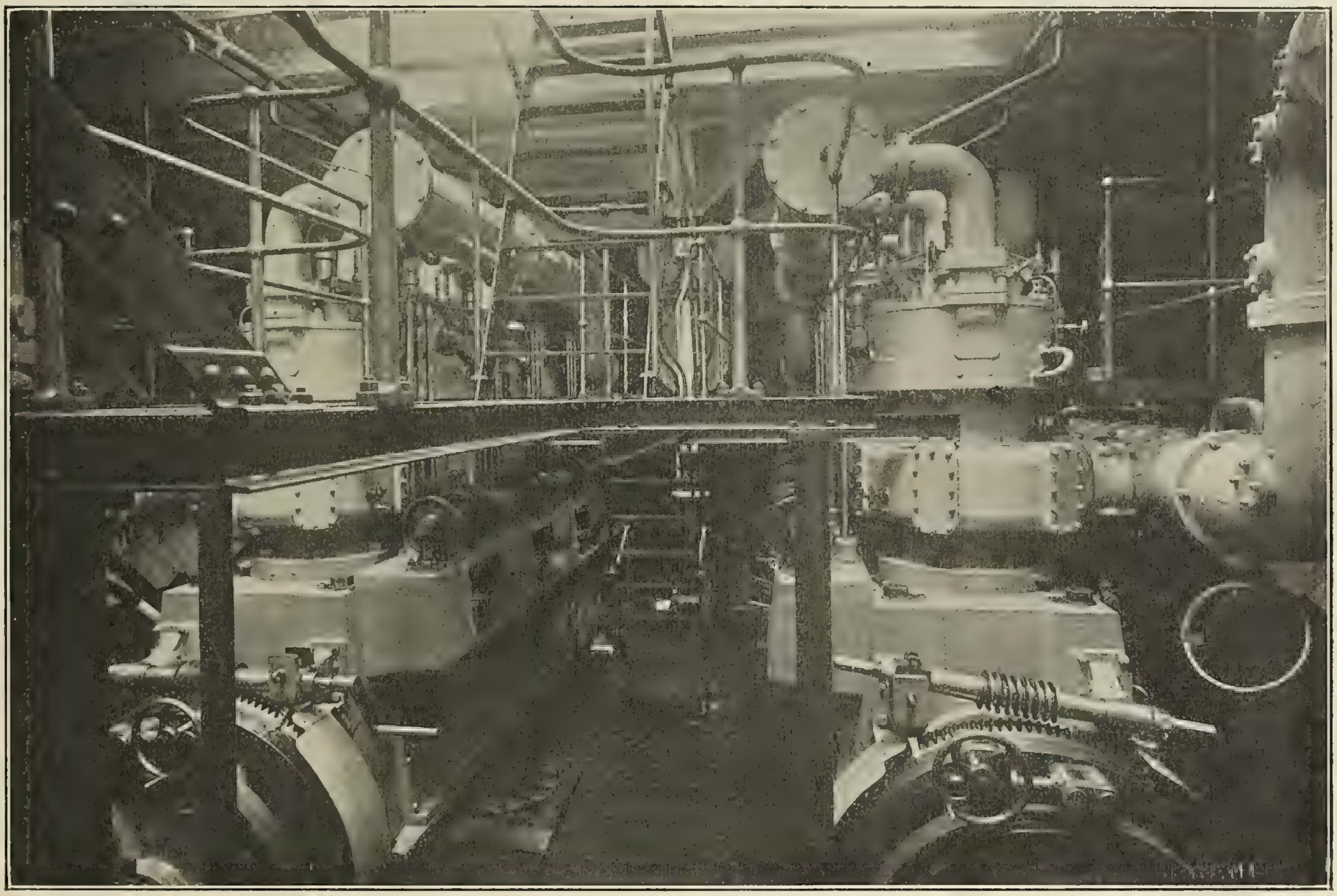


FIG. 9.—VIEW OF ENGINE ROOM, LOOKING FORWARD

Lubrication and Circulation

The lubricating pump draws from a tank located at the base of the engines. The oil is delivered at a pressure of from 2.8 pounds to 7 pounds per square inch, the pressure being adjustable by means of a valve and discharge cock, through a cooler and a double filter into a collector, which runs along the whole length of the engines. The cooling and filtering apparatus can be inspected while the engine is running. From the collector, the oil flows to all the shaft bearings and to all the connecting rod brasses. The oil runs from the casing back to the tank. The pump for the oil circulation through the pistons draws from another tank and delivers, as in the instance of the former pump, into a collector, whence the oil is distributed to the pistons by means of telescopic tubes; it then flows through pipes back to the tank. When the engines are standing, the oil circulation is ensured by a hand pump or by a centrifugal pump driven by an auxiliary engine. The piston lubrication is effected by one single pump driven by the indicator shaft; it draws from the collector

engines to be supplied either with lamp oil or with crude oil; the former is used for starting the engines when the cylinders are cold. The crude oil is contained in holds in the ship's bottom, whence it is drawn, either by a hand pump or, when the engines are running, by a small reciprocating pump driven by the main engines, and delivered through a filter into a tank placed above the engines, and where it can be heated by the circulating water proceeding from one of the cylinder heads as above stated. From the tank the oil fuel flows to the suction boxes of the oil fuel pumps. A second, auxiliary, filter is provided, and can be put in the oil fuel circuit for the purpose of enabling the main filter to be cleaned without stopping the engines. Two tanks containing the lamp oil, each having a capacity of 350 cubic feet, are located on deck. From these the lamp oil flows through a filtering tank before running to the suction boxes of the pumps.

Both engines exhaust into a collector, which is water cooled as far as the silencer; this is cylindrical in shape and contains baffle plates for deadening the noise of the exhaust. A pipe starts from each silencer and ends outside the hull right aft. The pipes are fitted with valves to prevent water entering them in bad weather, when the engines are not running.

The compressed air receivers for starting the engines are four in number, and have a total capacity of 113 cubic feet. They can be charged at a pressure of 995 pounds per square inch; the air pressure for starting is brought down to 497 pounds per square inch, maximum, through a reducing valve on the engines. The compressed air for the oil fuel injection is contained in two receivers, having each a capacity of 3.9 cubic feet. All the movements for starting the engines, reversing, regulating the fuel supply, regulating the pressure of the circulating oil, etc., are carried out from one single stand in front of each engine. The auxiliaries are driven by a Millot four cycle lamp oil engine, of 25 horsepower, at a speed of 330 revolutions. They include a two-stage air compressor for charging the compressed air receivers in the first instance, a dynamo supplying current for lighting, a fan in the engine room, and oil and water centrifugal pumps for cooling the engines when these are at a standstill.

The total weight of the engines, including shafting, flooring, and auxiliary apparatus, is equal to about 158 pounds per shaft horsepower.

Trials

The trials at the works consisted of a six-hours' run of each engine at full power, on lamp oil, and of a sixteen hours' run at two-thirds load of one engine on Autun shale-oil.

The full-power trials gave the following results:

Average speed, revolutions per minute....................234
Mean pressure of diagram.........100 pounds per square inch
Corresponding indicated horsepower.....................1305
Shaft horsepower (on brake).............................924
Mechanical efficiency...................................0.707
Petroleum fuel consumption reduced to standard fuel
of 10,000 calories per kg.:
Per indicated horsepower hour, .329 pound
Per shaft horsepower hour, .642 pound
Oil consumption (lubricating) per shaft horsepower....
.012 (British)
Oil pressure for lubricating........4.9 pounds per square inch
Oil pressure for piston cooling....35.5 pounds per square inch
Water pressure...................17.7 pounds per square inch
Scavenging pressure...............5.1 pounds per square inch
Fuel inlet pressure.............796.5 pounds per square inch
Oil temperature:
For lubricating:
Before entering cooler................102 degrees F.
After entering cooler..................98 degrees F.
For cooling piston:
Before entering cooler................204 degrees F.
After entering cooler.................154 degrees F.
Temperature of cooling water, inlet............46 degrees F.
Temperature of cooling water, outlet............98 degrees F.

A four hours' trial run of the ship with the engines alone took place off La Pallice, using lamp oil; this was followed by a six-hours' run, using crude oil—the fuel provided for her ordinary service. The contract speed was 10.05 knots. The speed at these trials was 10.3 knots, or a quarter of a knot above the contract speed.

The ship is provided with an auxiliary steam boiler, a steam windlass, a steam and hand steering gear, and steam winches.

Service

The *France* has been chartered for three years to transport minerals from New Caledonia to France, and she has recently started on her maiden voyage. It is expected that from 50 to 60 days will be required for the voyage, a saving of at least 30 days on the best passages under sail power alone.

This big five-master, when under a good pressure of canvas and with her twin engines going, is expected to be able to do 17 knots; and in calm weather, when progress through the water is obtained purely by her oil engines, it is expected that she will have a speed of about 10 knots.

Annual Report of Lloyd's Register of Shipping for the Year 1912-1913

At the close of the year ended June 30, 1913, 10,466 merchant vessels, registering over 22,500,000 tons gross, held classes assigned by the Committee of Lloyd's Register. During the year the committee assigned classes to 651 new vessels. Their registered gross tonnage amounted to 1,664,667 tons, which is the highest figure for one year ever recorded in the history of the society. Of the 651 new vessels, 593 represent steamers of 1,643,250 tons and 58 sailing vessels of 21,417 tons. Of the total, 1,010,876 tons, or about 60½ percent, were built for the United Kingdom, and 653,791 tons, or about 39½ percent, for the British colonies and foreign countries. During the twelve months ended June 30, 1913, plans of 752 vessels representing 2,000,000 tons of shipping were passed by the committee; and at the end of September the new tonnage actually in hand under the special survey of the society reached the total of 2,048,136 tons.

Motor Ships

At the present time there are in service twelve sea-going vessels classed with this society which are propelled by Diesel engines, and there are twenty-five others being built under the inspection of the society's surveyors. The motor ship *Fordonian*, after some preliminary trouble with her auxiliaries, made a non-stop run of twenty-six days' duration from the Clyde to Quebec. This vessel is now engaged on ordinary service on the Great Lakes of North America, and appears from the latest reports to be giving complete satisfaction. The *Hagen* made a voyage to New York and back, but experienced some difficulty with her auxiliaries on the return voyage. In both these cases the main engines were satisfactory.

The motor ships *Suecia, Pedro Christophersen, Siam* and *Annam*, as well as the *Selandia* and *Christian X*, previously built by Messrs. Burmeister & Wain, are giving satisfaction in their ordinary service. These builders have now in hand at Copenhagen and at Glasgow twenty-three sets of Diesel engines for fourteen vessels to be classed by Lloyd's Register. It should be mentioned that with further experience of these engines, increased economy has been effected, and the improvements have been such that they have also been applied to the older vessels. The confidence which has been obtained as a result of the successful working of the earlier vessels has led the builders to reduce the number of cylinders in the later designs from eight to six per shaft, and at the same time to make the cylinders of such larger dimensions that a considerably higher power will be developed upon each shaft.

It may also be mentioned that the motor ship *Juno*, as well as the *Vulcanus*, referred to last year, engined by the Nederlandsche Fabriek van Werktuigen en Spoorweg-Materieel, and managed by the Anglo-Saxon Petroleum Company, has proved so satisfactory in service that the owners have put them to work in their local trade in the East. In addition, these builders have now in course of construction at Amsterdam, eleven sets of Diesel engines for six vessels to be classed with this society.

In some vessels fitted with Diesel engines there have been minor difficulties with details, such as pistons, cylinder covers, etc., but these appear to have been overcome. It was only to be expected that in the early stages of the application of these engines to sea-going purposes some troubles would arise. As the number of engines increases and experience accumulates there will doubtless be a general improvement in the designs of details, which will thus be made more reliable to withstand the very severe conditions of high temperatures combined with the heavy stresses they have to endure. This desirable end would be facilitated by a frank interchange of the individual experiences of those interested in this type of engine.

Of the twenty-five Diesel-engine vessels building, referred to above, six are to the order of the Anglo-Saxon Petroleum Company and seven for the East Asiatic Company, of Copenhagen. It is interesting to observe from the latest published report of the latter company that they have also arranged to replace by Diesel engines the present steam engines of three of their vessels. These steam engines will be fitted in three other vessels building for them, which will be engaged in a trade where it will be profitable to use coal instead of oil, but for which trade the present three steamers are not suitable.

Size of Vessels

A feature which stands out very prominently in the operations of the society during the twelve months ended June 30, 1913, is the unprecedented number of vessels of upwards of 5,000 tons which have been assigned the 100A1 class. During the period in question no fewer than 120 such vessels have been classed. The latest returns of vessels being built to the society's classification show the same tendency towards the construction of vessels of large tonnage. The returns include twenty steamers of 12,000 tons and above. There are also numerous steamers of 10,000-12,000 tons each being built to the society's classification.

During the period under review plans have been approved for vessels of many types, including a coast-guard cruiser, a non-propelling rock-cutter barge, a pumping steamer for land reclamation, a steel screw lightship, and a train ferry for service between Quebec and Levis, besides other vessels for channel and river service and various coasting trades, as well as dredgers, barges, motor launches, etc.

The launch of the Cunard Company's quadruple screw turbine steamer *Aquitania*, 48,000 tons gross, from the yard of Messrs. John Brown & Company, at Clydebank, was an event of unusual interest during the year. In this steamer, the largest British vessel afloat, special attention has been given to an extensive system of subdivision by means of watertight bulkheads and flats, whereby she is rendered practically unsinkable.

Special Types

The number of vessels built and building upon the Isherwood system of longitudinal framing has largely increased during the last twelve months. Up to the end of June, 1913, 116 such vessels, representing 552,845 tons, had been assigned the society's classification, and there are now in course of construction under the inspection of the society's surveyors eighty-five of these vessels, registering 451,344 tons—altogether a total of 1,004,189 tons.

The year under review has witnessed a remarkable increase in the amount of tonnage classed by the society in respect of vessels intended for carrying oil in bulk. During the twelve months ended June 30, 1913, no fewer than forty-five such vessels, of 202,005 tons, received the society's classification. The demand for vessels of this description still continues, and there are at the present time eighty-three of these vessels, of 381,410 tons, preparing and in course of construction under the supervision of the society's surveyors.

The consumption of imported frozen and chilled meat, dairy produce, etc., is increasing yearly, and the question of the oversea carriage of such cargoes is one which has always received the closest attention of the committee, who view with much satisfaction the continued confidence which shipowners, underwriters and merchants place in the surveys carried out by the society's surveyors of the refrigerating machinery and appliances employed. The number of vessels holding the society's certificate in respect of refrigerating machinery (Lloyd's R. M. C.) continues to increase, being now 171. At the present time there are twenty-five vessels being fitted with refrigerating machinery under the supervision of the society's surveyors, the majority of them being of very large carrying capacity.

The use of wireless telegraphy and submarine signaling increases year by year. There are now recorded in the society's register book 1,932 vessels fitted with wireless telegraphic installations as compared with 1,392 at a corresponding date last year, and 806 fitted with submarine signaling apparatus as compared with 630 last year.

The number and gross tonnage of yachts classed in the society's register of yachts are 701 yachts of 115,599 tons. Of these, 292 of 100,968 tons are steam yachts and 339 of 9,103 tons are sailing yachts, while seventy of 5,528 tons are fitted with internal-combustion engines.

Panama Canal Tolls

In the November issue of International Marine Engineering, page 466, we referred to the manner in which the United States Government has woefully bungled the subject of tolls in the Panama Canal. Our statement, after criticizing the Government caustically, ended in the following sentence: "The action taken by the United States Government is a serious reflection upon American engineering ability and a great step backwards in these days of scientific attainments."

Many correspondents have asked us to state more fully the reasons for the position we have taken. We herewith answer all of these correspondents as concisely as possible.

Discrepancies of Net Tonnage Measurement

The assessing of tolls for traffic through the Panama Canal, as well as for port charges or for dry dockage, on the basis of net tonnage, is more or less farcical, for the following reasons:

1. Net tonnage bears no direct ratio to the actual size of the vessel, as it varies with nearly every type of craft, owing to the fluctuating deductions of space for machinery, crew and passengers.

2. It is not based on calculations sanctioned by any universally adopted standard.

3. It is not capable of being checked readily by the representatives of any government or parties interested in collecting charges for services rendered.

4. At the best no two persons can calculate it exactly alike, as the fundamental rule (Simpson's) upon which the areas of such irregular figures as the various sections of a ship must be calculated is in itself empirical.

5. Fast passenger ships, steam yachts and other special types of ships have a decided advantage over slow freight ships, the principal carriers of bulky cargoes by sea, inasmuch as the total deduction from their gross tonnage is greatly in excess of that allowed the full-lined slow ships.

6. In the proposed system of levying tolls for the Panama Canal a fixed charge per net registered ton is presented for loaded vessels and a fixed proportional amount is presented for each net registered ton when the vessel is light. This in itself is a tacit acknowledgment of the inadequacy or lack of flexibility of the "net tonnage" system. If a vessel is partly loaded, as often happens, the question will arise at once as to whether the toll is to be assessed at "loaded" rates or at "light" rates. Who, under the prescribed rules, can decide this matter equitably?

The advocates of net tonnage contend that it is equitable because only the earning capacity of a ship is taxed. It is claimed that in these days the net tonnage is measured by uniform rules throughout the world, yet an investigation of the fact develops that such is not the case. For example, it is stated in the report of the Commissioner of Navigation for 1911, in speaking of Panama Canal tolls:

"After deductions have been made the balance on net tonnage represents the assessable tonnage of a ship. Subject to the qualification suggested it may be said, roughly, that at the rate, for simplicity, of one dollar a net ton, one hundred gross tons would pay charges at Suez, Panama, New York or Liverpool of $61.00 (12/14/2) as the world's average net measurement, and the British and German average net measurement goes, of $66.00 (13/15/0) as the American average net measurement goes, and $72.00 (15/0/0) as Suez average net measurement goes."

Here, then, is a striking illustration that net measurement is not uniform throughout the world. A difference of $11.00 (2/5/10) on one hundred gross tons for different systems of measurement at present existing does not indicate any uniformity whatever. The discrepancy in this tonnage tax comes from the practice on some vessels of carrying cargo on deck. What are known as shelter decks, in which cattle have been carried many years, have not been uniformly assessed as cargo space except for passage through the Suez Canal. The United States Government does not include this in the tonnage space, and it is not known whether it will be included in the taxed space for passage through the Panama Canal.

A further illustration of the discrepancy is instanced by the Commissioner of Navigation when he makes the statement that where the German law permits a deduction of 37 percent in fixing the assessable tonnage, the Suez regulations allow a deduction of only 30 percent for these vessels. In calculating the tonnage on large vessels the space between the inner and outer bottoms is deducted from the gross tonnage. There is nothing to prevent a vessel carrying fuel oil in this space and thus avoiding tax on this very large space in most steamships. The fixed bunker space on seagoing vessels is deducted from the gross tonnage, but for short voyages what is there to prevent carrying cargo coal in the bunker space?

In France, subsidy and navigation laws are based on *gross* tonnage. This leads shipowners to seek the largest possible gross tonnage, while they join others in favoring the lowest possible net tonnage on which tolls, taxes and port charges are based in other countries.

A tabulation has been made by the Commissioner of Navigation as to the average deductions made by various countries for net tonnage. These show a variance from a minimum of 34 percent for the United States to a maximum of 47 percent for Roumania. The average for all nations is 39 percent.

Proposed Block Unit System

This system contemplates fixing the tolls at a definite rate of so much per unit, of the ultimate product of the length on the waterline, multiplied by the breadth of beam, and that in turn multiplied by the maximum draft of the vessel at the time she enters the canal.

For example, a vessel enters the canal, and very quickly it is ascertained that she is 300 feet long on the waterline, 40 feet beam, and has a maximum draft of 21 feet 6 inches. The procedure would be simply to multiply these dimensions together, thus, $300 \times 40 \times 21\frac{1}{2} = 258,000$. At one cent (½ d.) per unit this would make the toll charge $2,580 (537/10/0). At this rate of one cent (½d.) per unit, it will be found that the charge will about equal that of $1 (4/2) per net registered ton for the average steamer.

This system is the acme of simplicity and equity, for the following reasons:

1. Every vessel passing through the canal is assessed on a uniform basis.

2. The three dimensions represent the space the vessel occupies in the canal and locks at the time of passage. This space is limited, and should be charged for in direct proportion to the amount of it that is used by each passing vessel.

3. The toll can be calculated by the representative of the Government in a very few moments; the captain of the vessel can witness the calculation and be satisfied that he is being charged the right amount.

4. The draft element in the calculation assures that the vessel is only being charged for the exact amount of cargo that is aboard at the time. If the vessel is "light" no charge is made for cargo, of course; if in any degree loaded the charge is automatically fixed in proportion to the load.

5. The comparative advantage of this system is all in favor of the slow low-priced freighter, so that such bulky necessities of life as coal, lumber, etc., will pass through on the smallest canal charges, owing to the fullness of the lines of the slow carrier. Passenger vessels, vessels carrying high-priced freight, such as fruits and wines, steam yachts, etc., will pay relatively higher tolls owing to their finer lines.

Ferry Boat South Jacksonville

The steel ferryboat *South Jacksonville*, illustrated on page 513, was built a short time ago by the Merrill-Stevens Company, of Jacksonville, Fla., for the Jacksonville Ferry & Land Company. It was a repetition order from this company, and in several features an improvement upon former boats built for them. In fact, the new features have proved of such advantage to the service that it is the intention to alter an older boat so as to incorporate these improvements in it.

The new ferry runs between Jacksonville and South Jacksonville, thus connecting Jacksonville with St. Augustine and the surrounding country to the south. The most important highways into Florida lead through Jacksonville, and much of the traffic over them crosses the St. Johns River at this point. During the tourist season the traffic over these roads is very heavy, and in addition there is a heavy local traffic of trams and heavy trucks to and from large factories located across the river. The *South Jacksonville* was built especially to meet the requirements of this very important traffic.

Figs. 1 and 2 show the profile and 'midship section of the boat. The principal dimensions are as follows:

Length over all	153 feet
Length between perpendiculars	130 feet
Beam over all	42 feet
Molded depth	12 feet 3 inches
Full load draft	8 feet

The form of this hull is a copy of the wooden ferryboat *Duval*, which was built for this company about eight years ago by the Merrill-Stevens Company. Although it was somewhat of an experiment with the builders at that time it has proved such a success that when the order was placed for this new and larger boat the builders did not hesitate to adopt the model of the old boat with such slight changes as experience and difference in material made desirable; the main changes from the old boat being the superstructure, which will be referred to later.

As will be seen, the 'midship frames form in the main an inverted equal-sided triangle with the apex down at the keel and the base formed by the crowned deck beams, of which there is one for each frame, and all riveted strongly together with large gusset plate connections. Two lattice girders, spaced far enough apart to give room for the boilers, run practically the full length of the hull, and not only assist in transferring the deck load to the bottom frames but also distribute the heavy concentrated loads caused by the large loaded auto trucks commonly used in this district. This deck load is further taken care of by suitable angle struts connecting the deck beams with the frames below. Three transverse bulkheads give additional stiffness to the hull.

The keel is made from an inverted channel, with the web forming the bottom of the keel, to which each frame is strongly riveted by angle connections. The bottom plating is flanged and riveted to the channel flanges. The sections of the keel are all welded together, thus adding materially to its strength.

As will be seen in Fig. 2, the bottom is further stiffened at each frame by a plate web, the top of which is reinforced by a reverse angle supporting two rows of heavy channels, which not only distribute the load of the engine and boilers but also carry the thrust and spring bearings.

As shown in Fig. 1, there are two propellers and two stern posts, one at each end of the boat, which support the outer end of the tube encasing the propeller shafts at these points, and also support overhanging bearings of liberal length that take the weight of the propellers. The steel forgings forming these stern posts are run out aft at the bottom, forming the bottom bearings for the two partly balanced rudders. The vertical arms of these stern forgings are strongly riveted to the ends of the keel. Each propeller shaft tube is provided with the usual stuffing boxes, which are placed far enough inboard to be easily accessible.

There are two Scotch boilers with corrugated furnaces, built for 140 pounds pressure, placed alongside of each other in heavy steel saddles built up of plates and angles. As will be seen in Fig. 2, the shape of the hull lends itself admirably for the installation of large-size boilers, and still gives room for the propeller shaft running past in such a location that it could be floored over, thus forming no obstruction to the convenient firing of the boilers. The boilers are so placed that the stack is located amidships.

The engine is of the vertical two-cylinder, double-acting type 18 inches by 20 inches. Both cylinders are for high-pressure steam with rocking valves, operated by a Hackworth type valve gear. Within easy reach is the lever operating the throttle valve, which is of the balance type. All wearing surfaces are of liberal size. The A frames supporting the cylinders are exceptionally heavy and rigid, and still give easy access to all the moving parts. The connecting rods are steel castings, with split bronze-lined stub ends at the crank end, the other ends being forked to take the wrist pin. This engine is rated at 400 horsepower, using steam at 100 pounds pressure.

A very important feature of this boat is the arrangement of the superstructure. This, as will be seen, consists of a saloon deck running practically the full length and width of the main deck and a shorter and narrower hurricane deck covering the cabin located amidships, and upon which are located the two pilot houses. The entire main deck is given over to vehicular traffic, while the passenger accommodation is located entirely on the saloon deck above, where there is ample seating capacity for the large number of people who daily cross the river during business hours.

The main deck has four tracks for automobiles and teams separated by heavy timber rails. A very important feature is that the well, forming space for the smokestack and the engine, and at each end also encloses the stairways to the upper decks, is kept down to a minimum not only in width but also in length. The result is that the curves of the tracks are very easy at both ends of the boat, materially reducing the chances of damage to vehicles.

The support of the superstructure at the center of the boat is made up of two steel cantilever trusses, one over each side of the well and at these places supported by two rows of angle and channel columns, forming a framing around this well. The sides of the well are sheathed only part of the way up, giving ample ventilation for the engine and boiler rooms. The main supports of these trusses are two latticed columns, placed far enough in so as to not interfere with the easy curves of the tracks. These columns run all the way up so as to take the weight of the pilot houses and the steering stands, and they also form convenient enclosures for the steering connections, speaking tubes and bell connections from engine room to pilot houses.

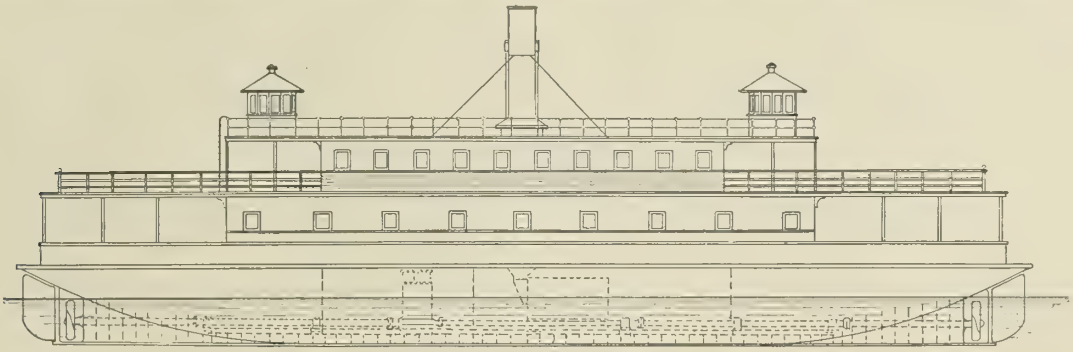


FIG. 1.—PROFILE OF FERRY BOAT SOUTH JACKSONVILLE

The stairways leading from the main deck to the superstructure are mainly for the use of the crew and for use of passengers in case of emergency, but they are occasionally used by the occupants of automobiles who wish to leave their cars while crossing to get a good view of the river.

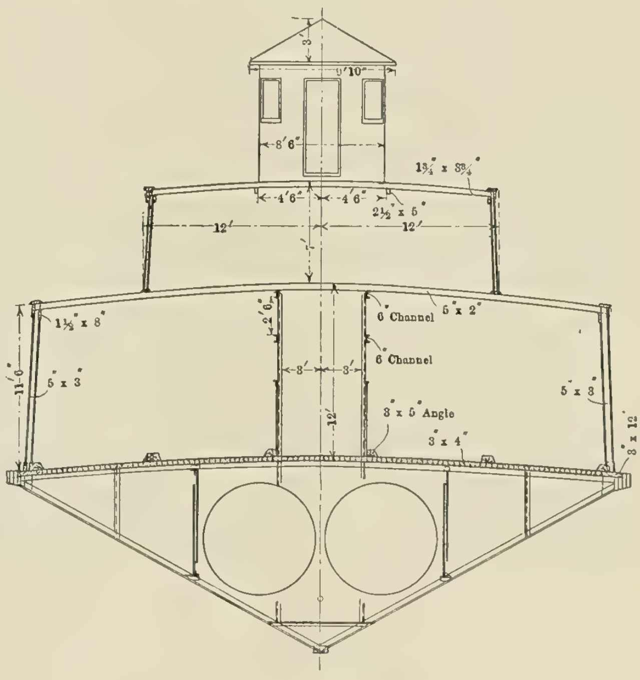


FIG. 2.—MIDSHIP SECTION

Each end of the saloon deck is built out in the form of two bridges, one at each side of the boat, and protected by gates. At the landings these bridges connect with similar bridges at the second story of the station. On landing, one bridge forms the exit and the other the entrance for passengers, thus allowing entire separation of passenger and vehicle service. The consequence is that this boat not only gives a maximum of space to the important automobile and truck service, but the transfer can be accomplished in a minimum of time, thus giving more frequent service during rush hours. It is this feature that the owners now want incorporated in their older boat, so as to be better able to take care of the constantly growing traffic. Another very important feature of this arrangement is the less chance of accident to passengers.

The *South Jacksonville* has a speed of 12 miles per hour when running free, and can reverse direction at full speed in less than one and one-half lengths. That she has been making a regular schedule of 15 minutes per round trip on a route 2,300 feet long, with terminals not opposite, is evidence of her handling power.

The hull, boilers and engines were designed by Mr. A. D. Stevens, president and naval architect of the Merrill-Stevens Company, to whom also is due the credit for the novel design of the hull and the arrangement of the main deck, the superstructure and the manner in which the ferry company now handles its passenger service.

Turbo-Generator Sets for the Great Northern Steamship Minnesota

The success of the steam turbine for driving auxiliaries on board ship has again been proved by a recent installation of turbo-generators on the Great Northern Steamship Company's transpacific steamer *Minnesota*. This ship is the largest and most luxuriously fitted steamship on the Pacific, and it will be recalled was built at New London, Conn., about ten years ago. She is 630 feet long by 73 feet beam, with a displacement of 33,000 tons.

Electricity is used extensively, not only for furnishing light, but also for driving the cargo winches and the steering gear. The passenger accommodations are heated and ventilated throughout by electricity. Current has been supplied by 75-kilowatt vertical compound engine sets, located on a flat at the forward end of the engine room, each set with a fore and aft shaft. The lighting circuit is 125 volts, and the power circuit 250 volts. It was the custom when at sea to run three generators—one for the lighting load and two for power.

The space occupied by these sets was cramped, and, furthermore, was open to the full temperature of the engine room. The arrangement of the old installation is shown in Fig. 1, looking across the starboard room and forward. Any repairs to the engines, such as broken crankshafts, required dismantling of the entire unit, as there was no head room over the cylinder and steam chest. Furthermore, partly because of inaccessibility these sets were a constant source of trouble, and one or more of them was frequently out of commission.

When it was decided to replace the sets, the advantages of the steam turbine were carefully considered, and finally the order placed with the Terry Steam Turbine Company, Hartford, Conn., for three 100-kilowatt, 2,200 revolutions per minute Type MC turbines, direct connected through flexible couplings to Crocker-Wheeler 125/250-volt, three-wire compound wound generators. One of these units is shown in Fig. 3 and the installation is shown in Fig. 2.

The difference in space occupied between the 75-kilowatt engines and the 100-kilowatt turbines is clearly seen by comparison of Figs. 1 and 2. The floor space of the engine sets was 12 feet by 5 feet 6 inches, while the over-all height was 8 feet. The Terry turbine sets measure 10 feet long by 4 feet 5 inches wide by 5 feet 3 inches high. All parts of both turbine and generator are readily accessible to the engineer. The generator armature and shaft may be removed without disturbing the turbine, by disconnecting the coupling, raising the bearing caps and taking off the top of the frame. Similarly, the turbine casing is split horizontally, and the rotor can be removed by taking off the cover of the casing and bearings without disturbing the generator.

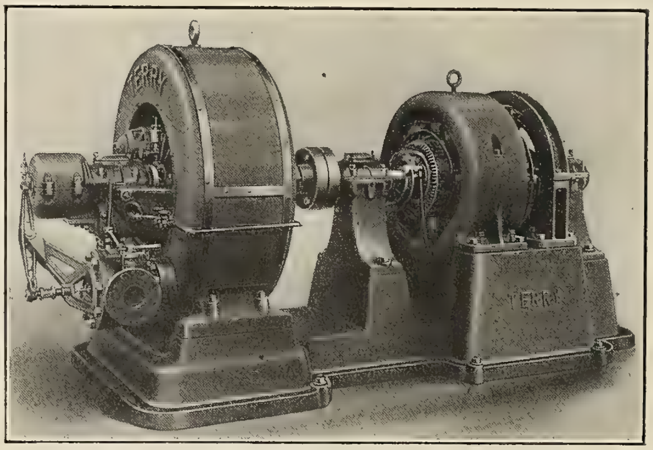


FIG. 3.—100-KILOWATT TERRY TURBO-GENERATING SET FOR S. S. MINNESOTA

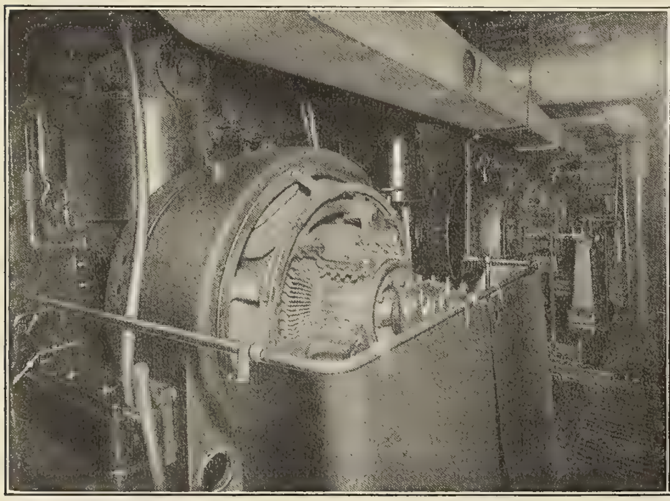


FIG. 1.—DYNAMO ROOM, WITH OLD 75-KILOWATT ENGINE SETS

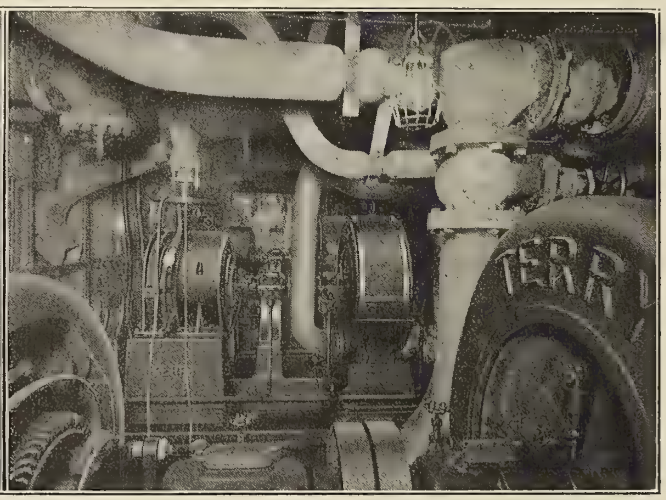


FIG. 2.—DYNAMO ROOM, WITH NEW 100-KILOWATT TURBINE SETS

These Terry turbines are of the single-wheel, multi-velocity type, with one 36-inch wheel. The jets and reversing chambers are of bronze, arranged with large clearances over the wheel. The bearings are all of the ring oil type with water circulation. The glands for non-condensing work are sealed with oil, while for condensing service they are sealed with low-pressure steam. Under neither condition can any oil enter the steam space, thus eliminating one serious source of trouble experienced with the old engine sets.

Steam is supplied to the turbines at full boiler pressure of 230 pounds. The designed exhaust pressure is 10 pounds, and the exhaust is piped to lead to the closed feed-water heater, to the low-pressure receiver of the main engine, to the main condenser, to the auxiliary condenser, or overboard.

The Crocker-Wheeler generators are of the inter-pole type, with single commutator of the shrink ring construction. The weight of a complete unit, including the base plate, is about 9,000 pounds.

The installation of these sets was made in record time by the ship's crew, under the direction of Mr. Adams, chief engineer, and Mr. C. C. Lacey, marine superintendent, and without any assistance from the manufacturers. Three days after the arrival of the shipment on the docks at Seattle the sets were installd, connected up, and the *Minnesota* left port with all three machines in service. Since that time, over a year ago, they have been in continual and successful service.

Steam Yacht Cyprus

Of special interest to yachtsmen this year is the palatial steam yacht *Cyprus,* launched from the yards of the Seattle Construction & Dry Dock Company, Seattle, Wash., Sept, 24, for Mr. D. C. Jackling of Salt Lake City. The vessel was designed and built under the supervision of Messrs. Cox & Stevens, New York, to whom we are indebted for the following particulars:

The dimensions of this new yacht are:

Length over all	230 feet 6 inches
Length on waterline	215 feet
Beam	28 feet
Draft	12 feet 6 inches
Speed	17 knots

This vessel has many striking features, as the owner imposed upon his architects the task of producing a vessel combining an unusually high maximum speed with the greatest possible accommodation for her dimensions. It was further required that the vessel should have a steaming radius of at least 4,000 nautical miles at cruising speed, and that it should be suitable for extended ocean cruising in heavy weather with comfort and safety to those on board.

Having these requirements in mind, Messrs. Cox & Stevens decided upon the steamer type of hull as possessing many advantages over the conventional yacht type. The architects further decided that in order to enable this vessel to maintain a high speed at sea, it was better to adopt the double-deck type, and accordingly the plating has been carried right up to the upper or shade deck, a feature which permits of unusual accommodation on the main deck.

An inspection of the lines shows a form that should be admirable both for speed and seaworthiness, as there is a moderately sharp entrance and a very easy run aft, considerable dead rise to all the sections and a pronounced flare above the waterline forward, which will tend to keep the vessel very dry under all conditions.

The hull is built throughout of heavy steel in excess of the underwriters' requirements for vessels of this class, and to ensure the maximum possible safety from collision special attention has been paid to the matter of watertight subdivision. There are nine transverse watertight bulkheads, built of heavy plating; there is a complete double bottom extending the full length of the vessel, and in addition, both forward and aft of the machinery space, a heavy watertight deck has been worked, very largely adding to the safety of the ship. The space beneath these watertight decks is utilized for stowage of fuel, water and other stores.

The form of hull decided upon has made it possible to secure an unusual amount of accommodation for the owner, his guests and for the crew of the vessel, this having been still further increased by the adoption of two four-cylinder triple-expansion engines, steam being supplied by a battery of Babcock & Wilcox boilers, using oil as fuel. The adoption of twin-screw propulsion and oil fuel not only largely reduces the amount of space assigned to the machinery department but also made possible a considerable reduction in the engine-room force.

The fuel oil, of which some 260 tons is carried in carefully constructed tanks formed by structural watertight bulkheads, is stowed partly in a large 'thwartship tank between the boiler room and engine room, and partly forward and aft in hold tanks under the watertight decks. All of these tanks are very thoroughly subdivided by swash bulkheads, and are provided

THE CYPRUS

with all the most approved appliances for ventilation, filling and emptying.

The outfit of auxiliaries is most complete, including an elaborate electric light plant with sufficient capacity to light the entire vessel, including two large searchlights and illuminating belt and to operate a powerful wireless outfit, there being storage batteries of ample capacity to take care of lighting the ship when the dynamo is not running. The vessel is steam-heated throughout, and an elaborate system of interior telephone communication has been provided. Hot and cold running fresh and salt water is supplied, and a large cold storage plant has been installed, making it possible to keep provisions for a long cruise in warm climates.

The hold space aft is given up to fuel tanks, water tanks and certain storerooms, while in the forward hold there has been arranged a most complete system of storerooms so that the vessel can be fitted out for extended cruising.

On the lower deck forward a very considerable portion of the space has been given up to cold storage space, there being separate rooms for meats and vegetables, and in addition on this deck are the owner's storerooms, including wine lockers, space for dry stores and provisions for the crew.

On the lower deck forward of these storerooms are arranged four staterooms, each with two berths, providing accommodation for the cooks, stewards and waiters, these rooms having adjoining them a separate toilet room. Forward of the stewards' and guests' quarters on the lower deck is the lower forecastle, providing berthing and messing accommodations for six oilers and firemen and twelve sailors, the deck force being separated from the engine-room force, and each having their own toilet room.

The accommodation for the rest of the crew consists of officers' quarters in the upper forecastle, where there are five separate staterooms, comfortably equipped with accommodation for all the officers of the ship with the exception of the captain, who has his own room and toilet in the pilot house, and the chief engineer, who has a room on the main deck abreast the engine-room enclosure, the officers' quarters having a large and comfortable washroom with shower bath and all conveniences.

With the exception of a small portion of the main deck, taken up by the officers' quarters, the entire space on this deck is utilized by the owner and his guests, and is arranged as follows:

At the extreme forward end of this space is a large stateroom extending the full width of the vessel with a bathroom adjoining. These staterooms are all finished in Colonial style, with massive mahogany furniture and doors, the bulkheads, ship's side and overhead being finished in ivory white. The bathrooms are all tiled on the floors and also have a wainscoting of tiling.

A passage leads on the center line aft from this stateroom, and on each side of this passage are two extremely large staterooms, the baths being arranged between each pair of staterooms. Aft of these comes a boiler enclosure, on the port side of which is arranged a galley, officers' mess room and laundry, also a bakery and a drying room. On the starboard side, abreast the boiler room enclosure, is a passage finished in teak, and this passageway communicates with the forward quarters on the main deck, and has a lobby where companion stairs lead up to the upper deck to the dining room.

This passage at its after end leads into the music room, 21 feet by 26 feet, extending the full width of the vessel, finished in Java teak, handsomely paneled, with furniture to correspond, and having overhead a very handsome dome skylight, so arranged as to give a very beautiful lighting effect in this room. In order to make this room especially attractive an unusual feature has been adopted: the openings on the side, instead of air ports, are large plate-glass windows, the lower portion being fixed for safety and the upper arranged to open, thus giving splendid ventilation and light.

Aft of the music room on the center line is the engine-room enclosure, the chief engineer's stateroom being on the port side of this enclosure, also a large trunk room. On the starboard side of the engine-room enclosure the space is arranged as an entrance hall and gun room or armory, the main starboard gangway opening into this space, and a hall running athwartships at the end of the engine-room enclosures communicates with a similar gangway on the port side close by the trunk room.

From this hall a passageway leads aft to the owner's private apartments, and one stairway leads down to the owner's and guests' quarters on the lower deck, and another stairway leads up to the after deck house, which is arranged as a smoking room, and has at its forward end a wireless room with a berth for the wireless operator.

The owner's private apartment consists of a large stateroom on the port side, with bathroom adjoining. On the starboard side, opposite the owner's private quarters, is placed a stateroom for his secretary, with bathroom adjoining and an office for the owner's use. The owner's quarters are finished throughout in selected Thibet oak, the bathrooms being fitted as in the forward end of the vessel.

The passageway between the quarters of the owner and his secretary runs aft and opens into the library, 22 feet by 16 feet, which extends the full width of the vessel. This room is finished throughout in Thibet mahogany, and has over it a small dome skylight. The windows are arranged in the same way as those in the music room.

Aft of the library the side plating of the vessel is cut away for a considerable distance above the bulwarks, leaving an open space across the deck, covered, of course, by the upper deck, having a large and comfortable upholstered seat running around the stern of the vessel and two large upholstered seats running across the vessel at the forward end. This part of the ship will be most attractive, being perfectly protected from the weather and at the same time open to the fresh air.

The companion stairs mentioned above lead from the hall at the after end of the engine-room enclosure to the lower deck aft, landing in a hallway on the center line of the ship. On each side of this hallway are two very large guests' rooms with bathrooms between. These rooms are finished throughout in Colonial mahogany furniture and doors with ivory white elsewhere. On this same deck and aft of the guests' quarters, accommodation is provided for four servants, with their own bathroom and also a large storeroom for the stowage of linen, pressing tables and all conveniences necessary for the use of the owner's servants.

The owner's dining room is placed in a large steel deck house on the upper deck forward of the smokestack, and accessible from the lobby in the passage on the main deck, this room being finished on the inside with very handsome selected India teak. This steel deck house contains, in addition to the dining room, a large pantry at its after end, connecting by dumbwaiter to the galley, which is located below. On the starboard side opposite the pantry there is a deck toilet.

The pilot house, reference to which has already been made, is placed directly on top of the forward deck house, the top of which is arranged as a navigating bridge, to be used in good weather by the captain or by the owner and his guests.

While the arrangement of the interior is remarkably successful, another most attractive feature of this yacht is her immense and practically uninterrupted shade deck, running from stem to stern, completely covered by awnings and affording a most delightful promenade.

The deck and life-saving equipment of the *Cyprus* is unusually ample, as she carries on each quarter a large lifeboat, and in addition three large and portable launches, one of these being a high-speed boat and the other two heavy, substantial launches, one being for the owner's use and the other for the service of the ship.

Annual Meeting of the American Society of Mechanical Engineers.—At the annual meeting of the American Society of Mechanical Engineers, which will be held at the Engineering Societies building, New York City, Dec. 2 to 5, papers on the following subjects will be presented: Boilers and Their Operation; Cement; Enameling; Fire Protection, with Special Reference to Turbo-Generators; Oils and the Novel Use of Sprinkler Systems; Gas Measurement; Gas Power Engineering; Lineshaft Bearings; Machine Tools; Management; Properties of Steam; Rope Drive; Steel Railway Cars; Textiles, Covering Mill Engineering; Vacuum Cleaning.

Shipbuilding Returns.—The Bureau of Navigation reports 98 sailing, steam and unrigged vessels of 38,059 gross tons built in the United States and officially numbered during the month of October. Ten of these vessels, aggregating 27,616 gross tons, were steel steamships built on the Atlantic and Gulf coasts. The largest was the *Matsonia,* of 9,728 gross tons, built by the Newport News Shipbuilding & Dry Dock Company, Newport News, Va., for the Matson Steamship Company, San Francisco, Cal. The next largest was the *Santa Cecilia,* of 6,309 gross tons, built at the Cramp Shipyard, Philadelphia, Pa., for the Atlantic & Pacific Steamship Company.

Ballin Sectional Watertube Marine Boilers

BY J. B. C. LOCKWOOD*

Two boilers of the Ballin sectional watertube type, using oil fuel under natural draft, were installed on the fast passenger steamer *Tacoma*, which was built by the Seattle Construction & Dry Dock Company, Seattle, Wash., and placed in service between Seattle and Tacoma last June. These boilers supply steam at 250 pounds pressure to a four-cylinder triple-expansion engine developing 3,650 indicated horsepower. In spite of the fact that they are placed in an open cabin without any fiddley overhead, they do not radiate sufficient external heat to discomfort passengers who are accommodated immediately alongside the boilers, as shown in Fig. 1.

Construction

The construction of this type of boiler is radically different from any other now in use. It is truly a sectional boiler, inasmuch as it consists of sections, nested together, but independent of each other, each section being a boiler in itself, having its own feed, steam and down-flow pipes.

FIG. 1.—BALLIN BOILERS INSTALLED IN OPEN CABIN, WITH SEATS FOR PASSENGERS ALONGSIDE

All of the generating tubes are straight and stand vertically, attached at the ends to bottom and top headers, the lower ones having D-sections and the upper rectangular sections. These headers are rolled from solid drawn steel tubes, and are grouped together, so that the lower ones form a continuous corrugated crown sheet over the furnaces, the upper ones a solid roof over the generating tubes. There are two groups of such sections, surrounding a combustion chamber extending the full length of boiler and closed on top by the steam drum, to which all of the upper headers are connected by short nipples.

The only bent tube in the boiler is the one connecting each section to the center bottom drum. The curvature of this tube takes up the unavoidable expansion and contraction in the section. Beyond the outer row of tubes each bottom header is connected by a vertical, straight tube to an outside bottom mud-drum.

All tubes used are seamless drawn steel 1½ inches in diameter, of No. 12 B. W. G. above and No. 10 B. W. G. around the furnaces. The tubes in the generating sections are screwed into the bottom headers with fine (14 per inch) threads, which have a taper of 1½ inches per foot. They are expanded into the top headers, and the holes in the top of the header are closed with plugs, allowing for the insertion or removal of each tube. Special expanders are furnished for expanding the screwed end of the tubes should any leak appear around the bottom threads.

From experience it has been found that the best material for these plugs is soft cast iron, as this material will not strip the threads in the headers when the plugs require removal for the purpose of inspection or repairs. The plugs have considerable taper on the threads, and are made hollow so that they are easily broken in case they stick. They are inexpensive to renew.

Each section has two staggered rows of tubes. The feed and down-flow tubes of each section are expanded in bosses, stamped into the bottom headers and screwed or expanded at the bottom. The curved tubes are connected to the bottom center drums by ground steel unions, which are protected from the fire by a row of firebricks.

The bottom headers extend to the outside of the casing, and are provided on the ends with screwed plugs, which project through, and are accessible from the outside of the casing for inspection and cleaning of the headers. Plugs are also provided in the lower headers over each of the bottom tubes. The nipples connecting each section to the steam drums are screwed into welded ends of the top headers and expanded into the drums. It will thus be seen that in order to extract a complete section it is only necessary to cut the top (or steam) nipple and the straight outside down-flow tube and unscrew the coupling near the center drum.

The casings are provided with large shutters on the top and sides, so that every part of boiler is accessible. To facilitate removal of such shutters they are provided with quick-opening dogs and latches.

Combustion Chamber

As already mentioned, the fire from both furnaces passes first into the common combustion chamber before entering between the generating tubes. With coal fuel, firing causes

* Consulting Engineer, Portland, Ore.

smoke, which soots the tubes, but in the Ballin boiler, if firing in the two furnaces is done alternately, this smoke is consumed in the combustion chamber by the hot fire entering from the opposite furnace and sooting of tubes is minimized. The hot gases have a chance to expand around the generating tubes, and are prevented from making a short-cut to the outside by baffles secured to the outside of the sections about half-way down the length of tubes, leaving, however, a small opening on top, under the top headers, to prevent dead corners. Between the outside of the sections and casings flue chambers are provided for the escaping gases, which thence rise up into the top chamber of the casing surrounding the steam drum and finally pass into the stack.

Against the sides of the casing, forming flue chambers, are laid feed-water heaters, consisting of coils of extra heavy pipe, which absorb the heat left in the gases after they have passed all of the generating tubes. Incidentally they keep the side of the casing cool.

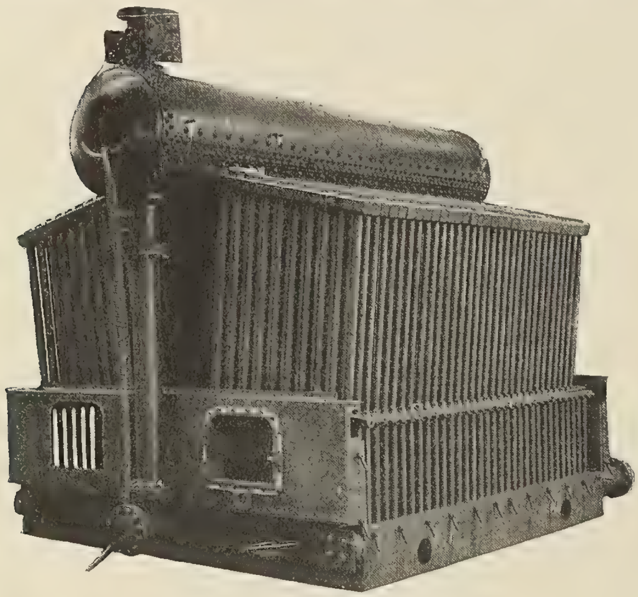


FIG. 2.—BALLIN BOILER, WITH CASING REMOVED

Circulation

As already stated each section constitutes a boiler in itself, so that the circulation in one section does not affect that of any other. As the most intense heat is always applied to that part of the section nearest the combustion chamber, and as the gases always pass first between the curved up-flow, or feed pipes of each section, the water contained in the generating tubes of this part of the sections is the first to rise upwards, and not being able to pass into the steam drum through the comparatively small nipples connecting each section with same, it is forced to deflect away from the drum and pass down through the cooler tubes further away from the combustion chamber. Thus a circulation inside of the section is set up and maintained as long as heat is applied. The bubbles of steam generated throughout the section, seeking the highest point,

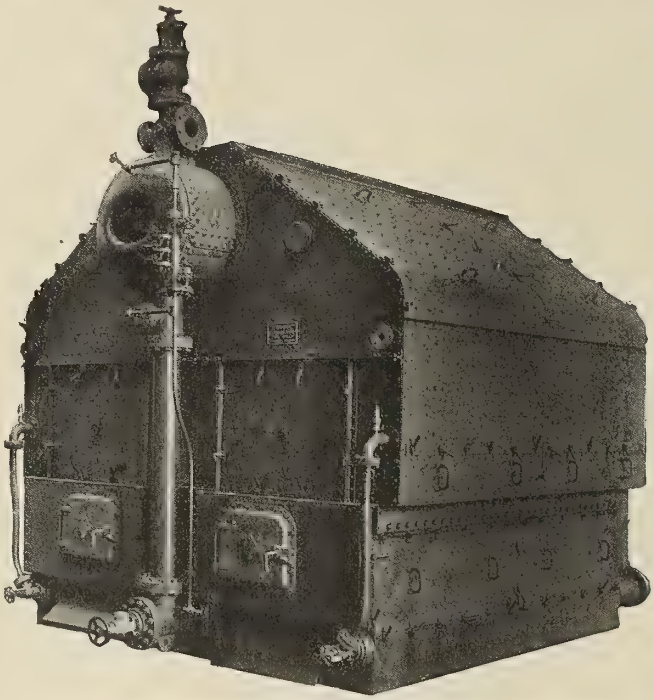


FIG. 3.—BALLIN MARINE BOILER OF 2,500 SQUARE FEET HEATING SURFACE

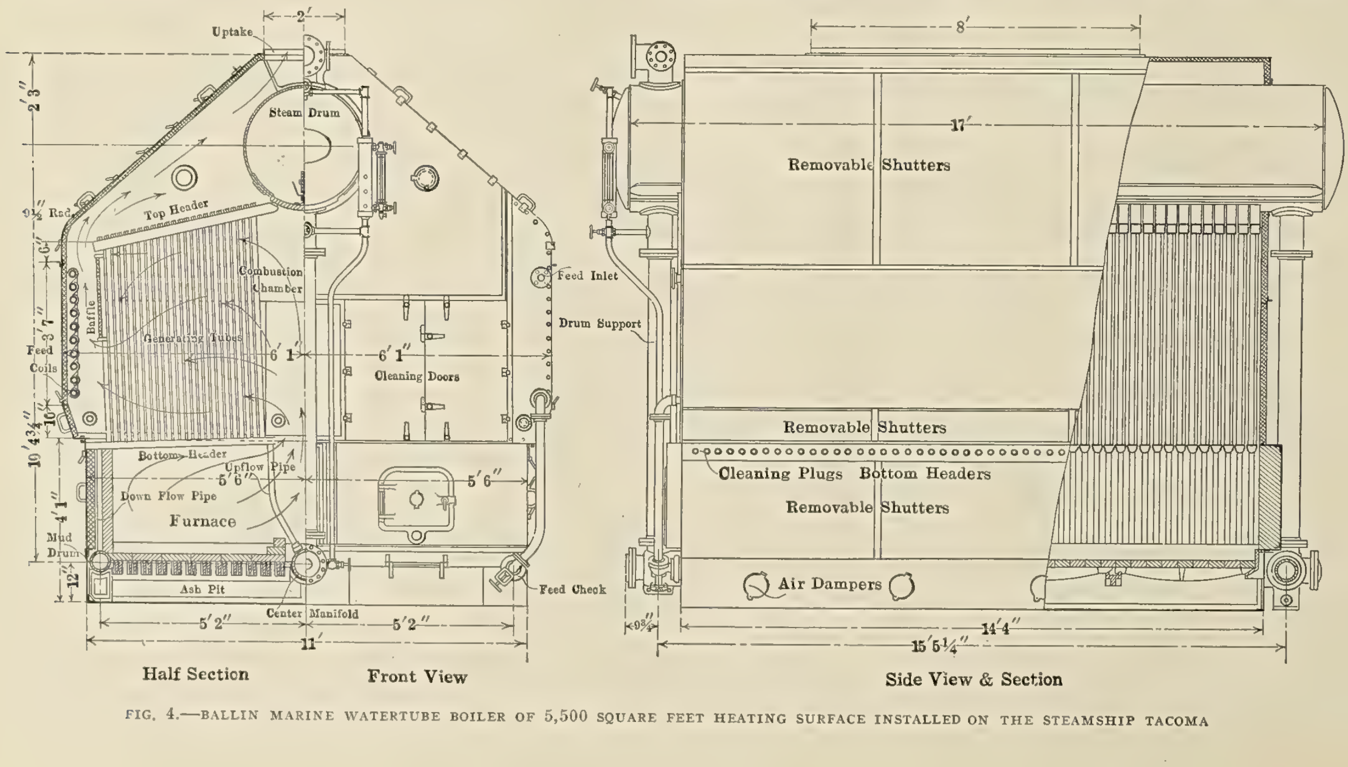


FIG. 4.—BALLIN MARINE WATERTUBE BOILER OF 5,500 SQUARE FEET HEATING SURFACE INSTALLED ON THE STEAMSHIP TACOMA

will naturally rise up and escape to the steam drum, entraining very little water.

While in practically every boiler now in use, separation of steam and water must take place in the steam drum, it will be seen that in the Ballin boiler the separation takes place in each section, a feature which constitutes an important step toward the ideal boiler.

In one of the Ballin boilers a section was removed after five years of constant use, and the lower D-shaped header was cut in two for inspection. No vestige of sediment could be found inside of the header, proving the rapid and perfect internal circulation. Some of the generating tubes of the same section were split lengthwise and showed clean metallic surfaces with the original ridges, left in drawing the tubes, still visible.

As under conditions of rapid generation of steam more water rises in a section than is formed into steam, this excess is taken care of by the down-flow pipes on the outside of the furnaces, through which this surplus is returned to the bottom mud-drums. Here it meets the fresh feed water of lower temperature, which causes all impurities contained in the feed water to precipitate in these drums, from which it is easily blown off.

On many occasions salt water had to be used in boilers now in service, a thing which means destruction to most boilers of this type. The fact that on such occasions salt never appeared in the water column proves that the circulation of the water does not pass through the steam drum, but is confined to each section. For this reason water can be carried very low in the steam drum, and almost the entire volume of the drum is utilized for steam only, for which it is intended.

In order to provide for proper equalization of the water level, and to take care of any water carried into the drums by entrainment, two large down-flow columns outside of the casing connect the bottom of the steam drum direct with the center bottom manifold. These columns also act as structural supports for the drum.

Advantages

From the above description it is seen that the steam generating parts of the boilers are homogeneous, consisting of all solid-drawn steel tubing, sufficiently strong to withstand 1,000 pounds internal pressure and not subject to deterioration from galvanic action or unequal expansion or contraction. While feed-water compounds were at first considered necessary, they have been discarded for the last four years as not needed. The boiler is exceptionally light and compact. The weight per square foot heating surface varies from 15 pounds in small units to 10.5 pounds in large units of 6,000 square feet and more. With oil fuel and natural draft the boilers evaporate from 5.5 pounds of water per square foot of heating surface, while with exhaust in the stack the two boilers installed in the Portland fireboat evaporated 8.8 pounds per square foot of heating surface.

In summing up, the qualities of the Ballin boiler which should be considered by naval architects, owners and engineers, are easy accessibility for quick inspection and cleaning of the inside and outside of all tubes, the possibility of making quick repairs with simple tools by the engineers themselves, light weight, dry steam, immunity to damage by use of salt feed, compactness, and the fact that they can be built in sizes up to 12,000 square feet heating surface, and are specially adapted for sea-going steamers on account of the small amount of water carried in the steam drums and the ability of keeping as steady a water level as in Scotch boilers.

New York Nautical School.—The U. S. S. *Newport*, loaned by the Navy Department to New York as a public marine school, was formally transferred, on Nov. 1, from the jurisdiction of the Board of Education of New York City to the State of New York. By the transfer the opportunity for a nautical education is now extended to young men throughout the State instead of only to young men residing in New York City. This school has been in existence for forty years, and the present school ship has accommodations for about 100 young men who wish to be trained for the mercantile service. The board of governors in charge of the school consists of J. W. Miller, Eugene F. Moran, Henry M. Randall, John H. Finley, Edwin T. Douglass, Charles H. Bessekeimer, George L. Norton, Fred B. Dalzell and John C. Halzel.

Progress of U. S. Naval Vessels

The Bureau of Construction and Repair, Navy Department, reports the following percentage of completion of vessels for the United States navy:

	Tons.	Knots.		Aug. 1.	Nov. 1.
			BATTLESHIPS		
New York	28,000	21	Navy Yard, New York	85.8	92.0
Texas	28,000	21	Newport News Shipb'g	91.7	96.0
Nevada	28,000	20½	Fore River Shipb'g Co.	40.3	49.2
Oklahoma	28,000	20½	New York Shipb'g Co.	37.7	48.7
Pennsylvania	....	....	Newport News Shipb'g	2.0	11.8
			TORPEDO BOAT DESTROYERS		
Cassin	742	29½	Bath Iron Works	99.3	100.0
Cummings	742	29½	Bath Iron Works	90.4	100.0
Downes	742	29½	New York Shipb'g	63.7	81.7
Duncan	742	29½	Fore River Shipb'g. Co.	98.0	100.0
Aylwin	742	29½	Wm. Cramp & Sons	96.9	97.4
Parker	742	29½	Wm. Cramp & Sons	93.5	95.2
Benham	742	29½	Wm. Cramp & Sons	92.3	93.0
Balch	742	29½	Wm. Cramp & Sons	91.8	92.6
O'Brien	742	29½	Wm. Cramp & Sons	7.1	14.9
Nicholson	742	29½	Wm. Cramp & Sons	7.3	13.6
Winslow	742	29½	Wm. Cramp & Sons	7.0	14.2
McDougal	742	29½	Bath Iron Works	12.6	34.3
Cushing	742	29½	Fore River Shipb'g	12.6	21.3
Ericsson	742	29½	New York Shipb'g Co.	9.6	15.1
			SUBMARINE TORPEDO BOATS		
G-4	....	....	Wm. Cramp & Sons	93.4	96.4
G-2	....	....	Newport News Shipb'g Co.	88.1	89.7
H-1	....	....	Union Iron Works	94.5	97.9
H-2	....	....	Union Iron Works	93.0	97.9
H-3	....	....	Seattle Con. & D. D. Co.	91.4	98.0
G-3	....	....	Lake T. B. Co.	69.6	74.2
K-1	....	....	Fore River Shipb'g Co.	85.9	94.0
K-2	....	....	Fore River Shipb'g Co.	85.0	91.8
K-3	....	....	Union Iron Works	81.6	88.6
K-4	....	....	Seattle Con. & D. D. Co.	78.6	88.0
K-5	....	....	Fore River Shipb'g Co.	72.9	79.3
K-6	....	....	Fore River Shipb'g Co.	72.7	78.3
K-7	....	....	Union Iron Works	71.9	78.5
K-8	....	....	Union Iron Works	71.0	76.4
L-1	....	....	Fore River Shipb'g Co.	6.1	13.0
L-2	....	....	Fore River Shipb'g Co.	6.1	13.0
L-3	....	....	Fore River Shipb'g. Co.	6.1	13.0
L-4	....	....	Fore River Shipb'g Co.	5.5	13.0
L-5	....	....	Lake T. B. Co.	00.0	7.4
M-1	....	....	Fore River Shipb'g Co.	00.0	9.7
			COLLIERS		
Nereus	20,000	14	Newport News Shipb'g Co.	93.6	100.0
Kanawha	14,000	14	Navy Yard, Mare Island	1.3	9.4
Maumee	14,000	14	Navy Yard, Mare Island	1.3	5.3

Programme of Naval Architects' Meeting

The Society of Naval Architects and Marine Engineers will meet in the Engineering Societies building, New York City, at 10 A. M., Dec. 11 and 12, to discuss the following papers:

December 11

"Relative Resistance of Some Models with Block Coefficient Constant and Other Coefficients Varied," by Naval Constructor D. W. Taylor, U. S. N.

"Experiments on the *Fulton;* Effect of Bilge Keels," by Prof. C. H. Peabody.

"The Safety of Passenger Ships at Sea," by Mr. G. W. Dickie.

"Structure of Vessels as Affected by Demand for Increased Safety," by Mr. William Gatewod.

"Stability of Life Boats," by Prof. H. A. Everett.

"A Substitute for the Admiralty Formula," by Mr. E. A. Stevens.

"Diesel Engine in Marine Propulsion," by Mr. John Reid.

"The Evolution of the Lightship," by Mr. George C. Cook.

December 12

"Construction and Operation of Western River Steamers," by Mr. R. C. Wilson.

"The Influence of National Policies on Ships' Design," by Capt. W. L. Rogers, U. S. N.

"Strains in Hulls of Ships, Showing the Effects of Pitching and Rolling," by Mr. James E. Howard.

"Change of Shape of Recent Colliers," by Naval Constructor S. F. Smith, U. S. N.

"General Organization of a Navy Yard," by Capt. L. S. Van Duzer, U. S. N.

"Notes on the Performance of S. S. Tyler," by Mr. E. H. Riggs.

Spring Meeting of the Institution of Naval Architects.—The next annual meeting of the Institution of Naval Architects will be held in London, April 1, 2 and 3, 1914.

Electrically-Driven Cargo Boat Tynemount

BY C. VAN LANGENDONCK

The *Tynemount* is an up-to-date, electrically-driven cargo vessel, recently built by Messrs. Swan, Hunter & Wigham Richardson, Ltd., of Wallsend-on-Tyne, to the order of the Electric Marine Propulsion Co., Ltd., Montreal, for service on the Canals and Great Lakes of North America. The hull is 250 feet in length by 42 feet 6 inches beam and 19 feet depth, molded. There are two masts, a forecastle deck and navigation bridge forward, and a poop deck aft. There is one steel deck, and three cargo-holds, with seven large hatches. On the deck are steam winches for working the cargo with three 3-ton derricks.

bulkhead. In the forecastle is the accommodation for the officers, crew, and oilers, while above are the captain's sleeping room and office, together with wheelhouse, etc. In the poop are the rooms for the engineers, the galley, the dining saloon and the crew's mess room.

Among other special features may be mentioned a strong oak fender along the sides of the vessel and forward for protection in the locks, a strong oak quarter badging round the stern, wrecking wells, *i. e.,* vertical trunks to give access from the deck to the double bottom when the holds are full of cargo, a bowsprit for steering, etc.

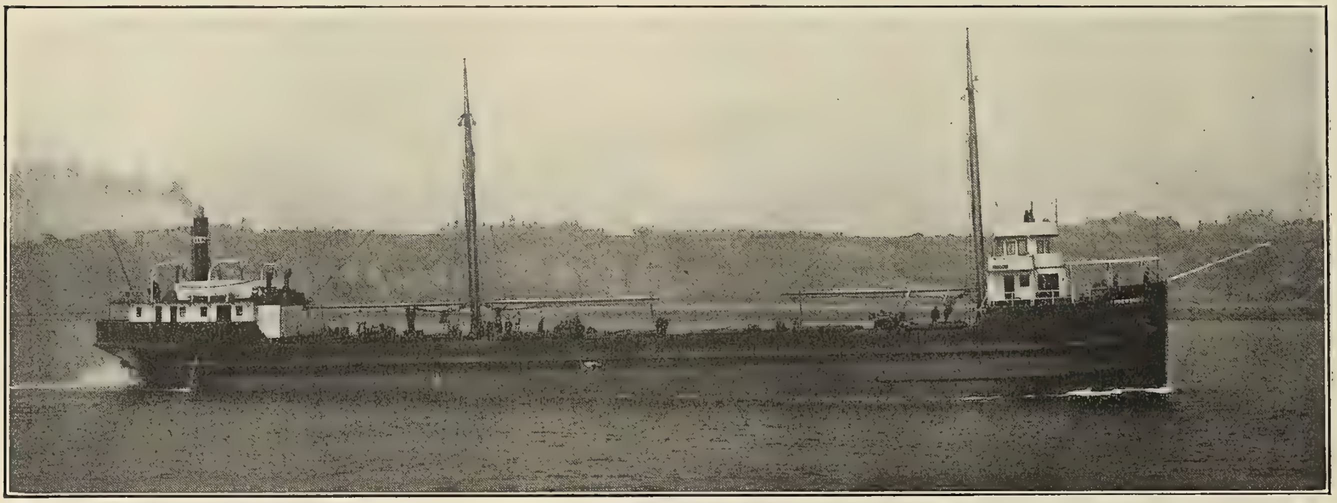


FIG. 1.—NEW LAKE FREIGHTER TYNEMOUNT, PROPELLED BY ELECTRICITY

Deck Machinery

The deck machinery consists of a steam windlass, a steam steering gear, and the three steam winches for working cargo and warping. The auxiliary machinery is supplied with steam from two Cochran donkey boilers placed in the poop and fired by means of oil fuel. The vessel has a double bottom throughout with heavy flush fitted tank top plating; under the cargo holds the double bottom is adapted for carrying water ballast, as is the forepeak, while the tank under the engine room and the after peak may be used for oil fuel. There are also two tanks for oil fuel on the deck forward of the poop

Propelling Machinery

The machinery is accommodated right aft under the poop. The prime movers of the installation consist of two 6-cylinder high-speed engines of the Mirrlees-Diesel type. They are each capable of developing 300 brake-horsepower at 400 revolutions per minute on the 4-stroke cycle, the diameter of the cylinders being 12 inches and the stroke 13½ inches. The engines are totally enclosed, forced lubrication being employed throughout. A substantial bedplate is joined with the alternator bedplate at the flywheel end of each engine, the whole being secured to the raised engine seatings, which form part of

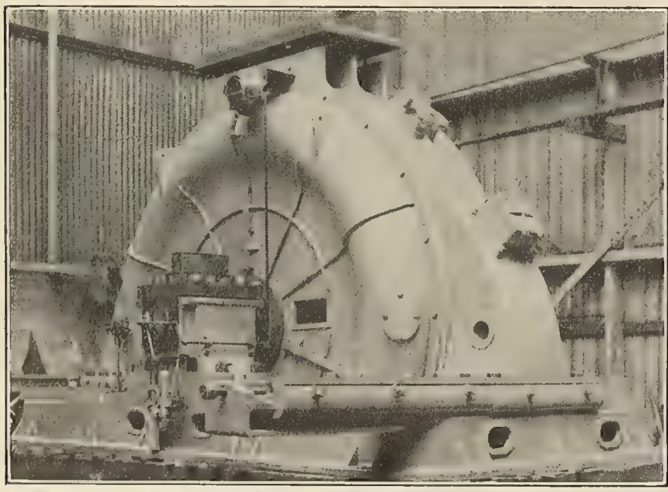


FIG. 2.—MOTOR ASSEMBLED IN THE BUILDERS' SHOP

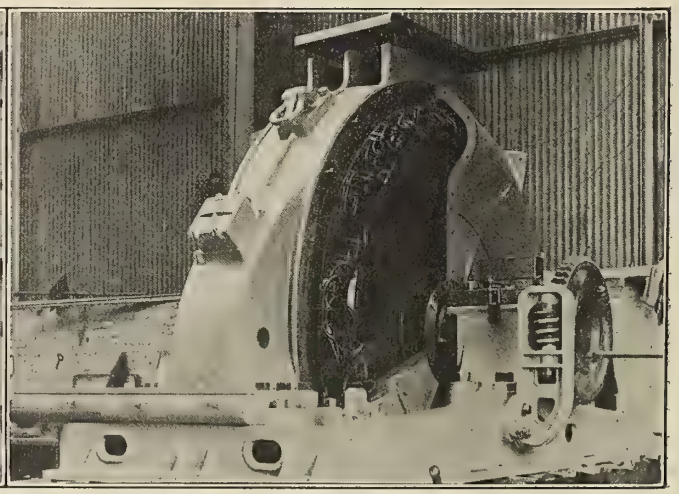


FIG. 3.—MOTOR WITH GUARD REMOVED TO SHOW WINDING

the ship's structure on both port and starboard sides of the engine room. The six cylinders of the engine are divided into two groups of three cylinders each, the vertical shaft which drives the cam shaft being placed between the two groups. The crank shaft is made in two pieces, the gear wheel which transmits the motion to the vertical shaft being bolted between the two flanges of the central coupling, and these flanges are turned solid with the shafts. The engines, which are coupled to the alternators in the usual manner, are placed at the forward end of the machinery space, on the port and starboard sides. A suitable hand-lever barring gear working in an internal rack on the flywheel of each engine provides for turning the engine into the starting position when required.

Control of the Engines

Starting is effected by means of compressed air, three cylinders only being fitted with starting valves. These are arranged on the three cylinders at the flywheel end of the engines, and their operation is rendered easy for the engineers in charge by a system of bell crank levers and coupling rods transmitting the motion from a control pillar placed on the engine room floor in close proximity to the air receivers of the engines. A device for stopping the engine and means of controlling the amount of air delivered by the air compressor are also provided on the same control pillar. Near at hand is the electric controller of the transmission system, the whole providing a compact and centralized arrangement for the operation of the propelling machinery.

At the after end of each engine, a 3-stage air compressor is fitted, direct driven from an extension of the engine crank shaft. This extension also provides means for driving the lubricating and circulating water pumps.

The two groups of cylinders comprising each engine are carried by two enclosed-type columns, each cast in one piece and provided with inspection doors of ample size. To these columns, on the front or cam shaft sides of the engines, cast iron brackets are fixed, which support grating platforms running along the whole length of each engine on the front side; these platforms provide easy access to the valve gear and valves.

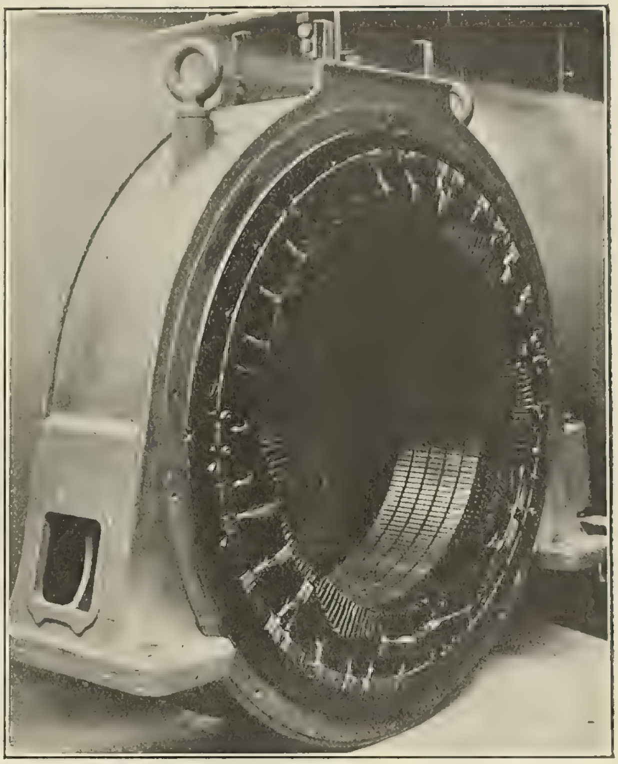


FIG. 5.—STATOR OF ALTERNATOR, WITH GUARDS REMOVED TO SHOW WINDINGS

Valves and Pumps

The valves are situated in the cylinder covers, the fuel valve being of the ordinary needle type, opening vertically upwards; the exhaust and air valves open downwards, and all are operated by cams and levers in the usual manner. An important feature of these levers is the provision of the hinged and bolted joint in each, which allows, by the undoing of one bolt, any lever to be folded back, and by this means the work of withdrawing the valves is reduced to a minimum. All the

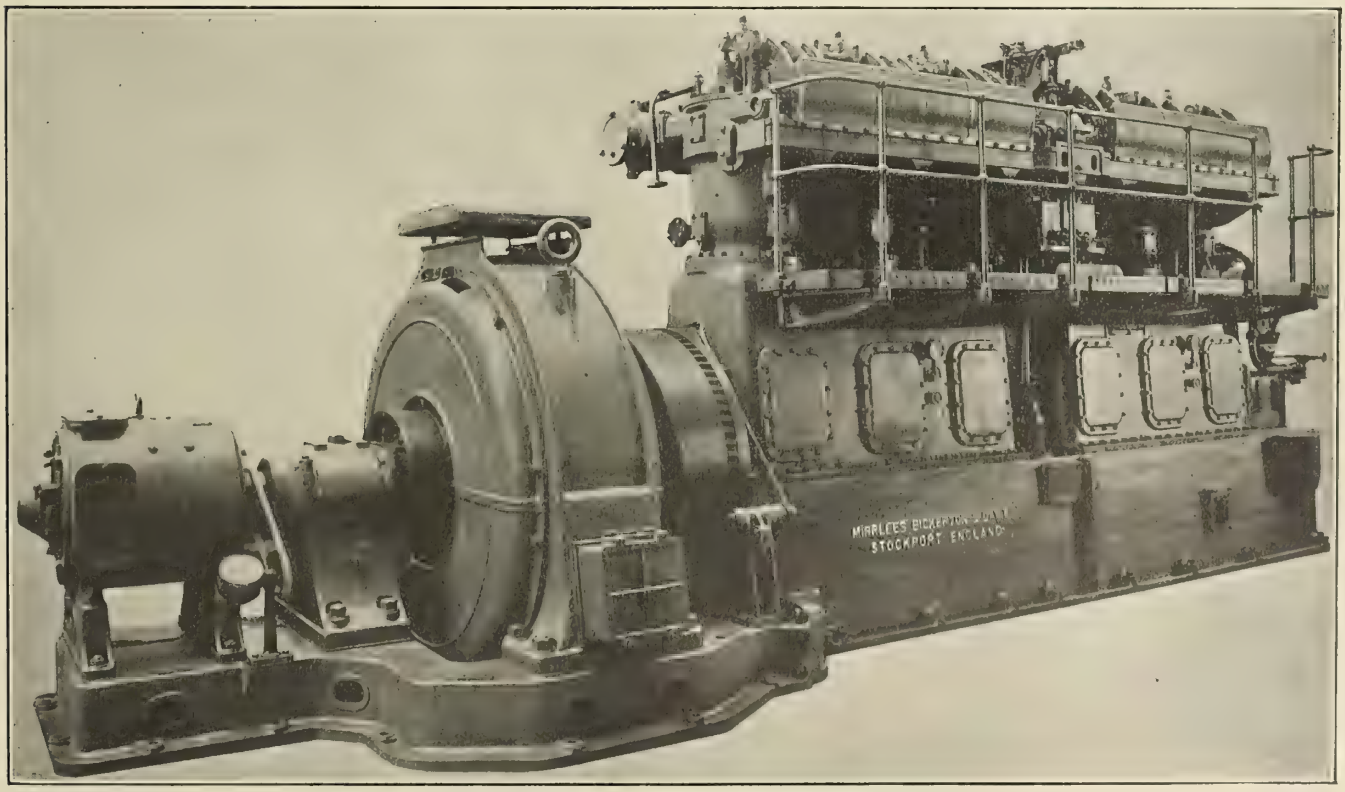


FIG. 4.—ONE OF THE MIRRLEES DIESEL GENERATING SETS FOR THE TYNEMOUNT

valve seats are made separate from the cylinder covers, and can be withdrawn bodily with the valves. Spare valves and seatings are carried, and thus all grinding-in can be done on the bench at the engineer's convenience. The pistons are of the trunk pattern and have separate heads.

The fuel pumps for delivering oil to the cylinders are situated on either side of the vertical shaft gear-casing, and are driven by eccentrics from the camshaft. Each of these eccentrics operates a small crosshead to which are fitted the three plungers of each pump. Fuel oil is fed by gravity to the fuel pump suction chamber from the ready use tanks, which are situated on the forward bulkhead of the engine room. The amount of oil passing through the cylinders is determined by the governor, which is fitted on the upper portion of the vertical shaft, a system of coupling rods and levers is connected from the governor arm to a small spindle passing through the fuel-pump suction chamber and to this spindle tappets are fixed which determine, according to the position of the governor, the length of time the fuel pump suction valves remain off their seats; and until the suction valves are closed no oil will be delivered to the fuel valves on the cylinder covers.

The circulating water, after passing through the engines, goes to the exhaust pipes, which are water-cooled. Thence it passes from each engine, through a water-flow indicator, into a branch piece from which two pipes are led, one pipe going to the discharge valve on the ship's side and the other, by means of a by-pass, to the suction side of the circulating pump. By this means, warm water can be mixed with the incoming water when the ship is sailing in cold waters. When the ship is running in fresh water, it will be possible, by means of a special arrangement, to pass the hot circulating water from one engine into the feed tank of the donkey boilers. When the engines have been stopped and are cooling down, it has been arranged that the sanitary pumps may pass circulating water through them and thus lessen the chances of precipitation of salts or alkaline matter in the jackets.

Generators and Motor

The electrical equipment consists of two Mavor and Coulson three-phase alternators, each direct coupled to one of the Diesel engines. The alternators, when running at their normal speed of 400 revolutions per minute, each give an output of 500 volts and 270 amperes per phase, which absorbs the full power of the engine. They are provided with six and eight poles respectively, making the frequency of the current 20 periods per second and 26.6 periods per second respectively. An exciter is direct-coupled to each alternator and is capable of giving an exciting current of 30 amperes, which can be increased up to 50 amperes while maneuvering.

The current from these two generating sets is led to a 500 brake-horsepower Mavor and Coulson patent induction motor of special construction. The rotor of this motor is of the squirrel-cage type, but the stator is provided with two different and entirely separate windings, one of 30 and the other of 40 poles. When these two windings are supplied with current at 20 and 26.6 periods respectively, they give the same synchronous speed of 80 revolutions per minute. The motor will then absorb the full power of both engines and drive the propeller to which it is direct coupled at a speed of 78 revolutions per minute. This propeller speed corresponds to the fastest speed of the vessel. In order to obtain a slower speed, the connections are altered so that the alternator giving 20 periods supplies the 40 pole winding of the motor; the alternator giving 26.6 periods can be shut down, and the 30-pole winding of the motor is also out of use. The synchronous speed of the motor with the propeller is now reduced to 60 revolutions per minute. One of the engines only is available, but as the speed of the ship is reduced to about three quarters of the normal, half of the total horsepower is ample and the great advantage is obtained of being able to entirely shut down that part of the plant which is not required at the low speed. The motor is readily reversed by interchanging the connections of two of the phases. It will be noted that the two alternators, when both are at work, are connected to entirely separate circuits and they are, therefore, never run in parallel.

Switch Gear

The switch gear, by means of which the necessary changes of connection are made, is extremely simple; it consists of two parts: A main switch of the tramway-controller type, having five different positions: "full ahead," "half ahead," "stop," half astern," "full astern," and of a second switch, the purpose of which is to introduce resistance into the shunt circuit of the exciter.

The contacts of both switches work under oil, but it is inadvisable that the contacts of the main switch should be required to break the large main current flowing to the motor. The two switches are, therefore, interlocked so that it is impossible to work the main switch except when all the resistance has been introduced into the exciter field coils. There is then practically no excitation and the whole system is "dead." With the resistance in the exciter field circuit, the main switch can be moved to any one of its four working positions, and, when the main connections have been made for the new running position, the shunt switch lever is pulled over so as to cut out the resistance and restore the excitation. Until the main switch is definitely on one set of contacts the shunt switch is locked so that the excitation cannot be restored. The whole handling of the ship can be carried out by means of two levers which are so interlocked as to be practically fool-proof. In the present instance, these switches are in the engine room, but it is evident that by lengthening the connecting cables they could be placed on the navigation bridge.

The number of electrical instruments provided has been kept down to a minimum. There are provided only one ammeter and one voltmeter for each alternator and an ammeter and voltmeter for each exciter. The handling of the switch gear is so simple that there is no necessity for multiplication of measuring instruments.

Advantages of Electric Drive

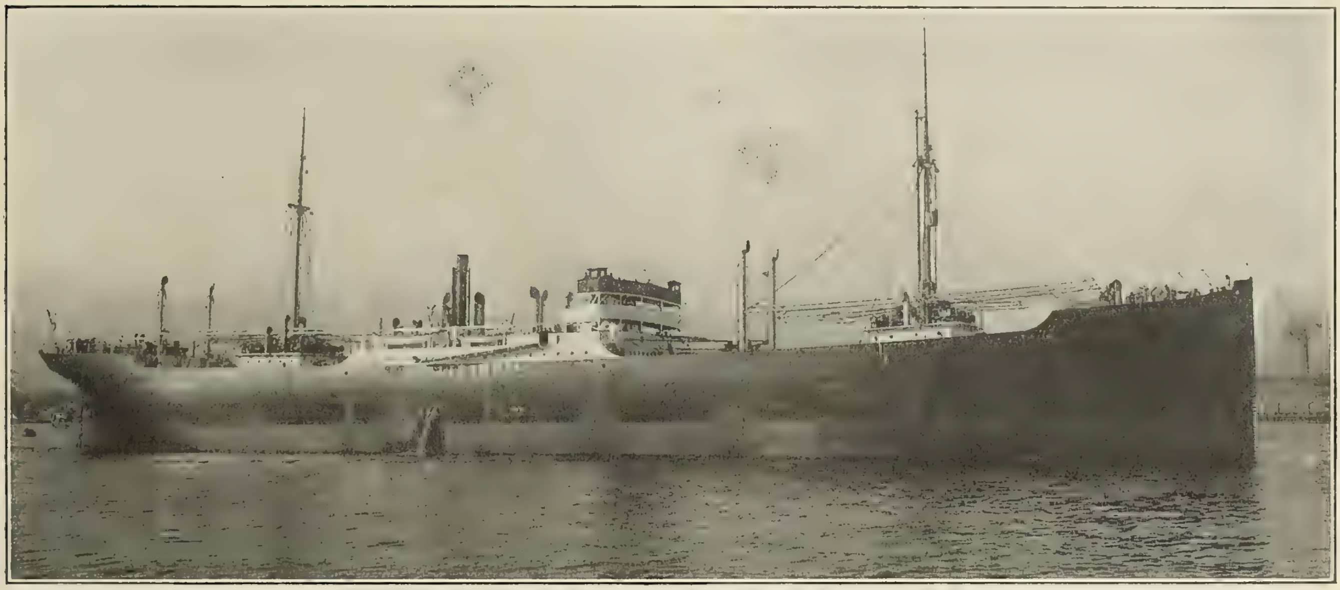
The electrical drive permits the speed of the ship to be altered without altering the engine speed. It also permits a convenient gear ratio to enable the engines and the propeller respectively to be run at their most efficient speeds, and also provides for the ready reversal of the propeller while the engines continue to run in their normal direction. In addition to the above advantages, it is found that in many cases the system allows of a reduction in the machinery space, and also in the bunker space required, thus increasing the cargo capacity of the vessel. As a subsidiary advantage, it lends itself readily to distant control, and in any case where it may be found advisible the switch gear can be put on the bridge and the control of the motor driving the propeller be put into the hands of the navigating officer.

Correction.—A reader calls attention to an error in the instalment of "McAndrew's Floating School" published in our November issue, where it is stated that in all water and steam pipes (standard, heavy and extra heavy) the internal diameter always remains the same. As a matter of fact, the excess metal is always on the inside, the outside diameter remaining the same. For instance, with 1-inch pipe on standard pipe the inside diameter is 1.049, the outside 1.315; on extra strong the diameter is .957 inside and 1.315 outside; on double extra strong the diameter is .599 inside and 1.315 outside. In threading pipe the same dies are used for all weights of pipe, which could not be done if the excess metal were on the outside.

The California, an 11,000-Ton Motor Ship

BY J. RENDELL WILSON

Outside of Russia no firm can claim to have had anything approaching the experience with large ocean-going motor ships that Burmeister & Wain have had. The nearest approach from a point of numbers is that of the Werkspoor firm, although, of course, the A. B. Diesels Motorer & Benz Company have turned out dozens of Diesel-engined craft of under 500 horsepower, but as yet they can hardly be put in the same category as the builders of 2,000-horsepower machinery, although it will not be long before they will be in this position. Burmeister & Wain have now completed in the *California* their sixth large Diesel-engined ocean-going vessel, and the trials were successfully run on Sept. 30 last. This leaves ten more motor ships of very similar size now on order at the same yard, a complete list of which was published in the July issue of INTERNATIONAL MARINE ENGINEERING. The clockwork regularity with which these boats are being turned out is worthy of very favorable comment.



MOTOR SHIP CALIFORNIA

The *California* was built for the United Steamship Company, to the Bureau Veritas, Class 1, Div. ✣, 3/3 L. I. I. P. R. A. and C. P., and her general dimensions are as follow:

Length	405 feet
Breadth	54 feet
Depth	35 feet
Draft	23 feet 3 inches
Displacement	11,040 tons
Deadweight capacity	7,200 tons
Total power	2,700 I. H. P.
Number of screws	2
Speed on trials	11.84 knots

Her propelling machinery consists of two eight-cylinder, single-acting, direct reversible Burmeister & Wain Diesel engines of the enclosed four-stroke type, with cylinders 21.6 inches bore by 29.2 inches stroke. At 140 revolutions per minute each motor develops 1,350 indicated horsepower, and so while slightly larger than those in the *Selandia* they turn at the same speed. Generally speaking, these engines are of the same design, and therefore need no description here, but the modifications that have been made are of interest. Instead of fitting one fuel pump and a distributer to each set of four cylinders, each cylinder now has its own fuel pump, thus affording a more equal supply to each individual cylinder. Cutting out one or more cylinders is now an easier matter, as before, when one cylinder was cut out at the distributer, there was a tendency for the other cylinders to receive too much oil. Another minor, but not unimportant, alteration is that of the reversing, which is now carried out by means of a compressed air motor of similar construction to the Brown's gear as applied to marine steam engines. These alterations, the makers state, have been proved to give good results.

The auxiliary machinery also shows modifications inasmuch as the cargo winches are steam driven, the steam being generated by an oil-fired boiler of 1,000 square feet heating surface and of the Korting type. Consequently the *California* is equipped with a slender funnel, whereas all previous Burmeister & Wain motor craft exhausted through one of the hollow masts about 30 feet above the deck. For auxiliary purposes there are also two three-cylinder, four-stroke Diesel engines of the non-reversible enclosed type, each developing 180 brake-horsepower at 210 revolutions per minute. Each of these motors drives a 50-kilowatt, 100-volt direct-current dynamo and a three-stage air compressor. The latter charges reservoirs with air for starting, reversing and fuel injection, while the dynamos supply current for a number of small motors which operate the cooling water pumps, forced lubrication pumps, bilge pumps and the fuel tank service pump, also current for the Hele-Shaw steering gear, the anchor windlass and electric lighting of the ship.

The fuel consumption, including the main and auxiliary engines, was 173 grammes per brake-horsepower on the trials, which were carried out to the satisfaction of the owners, who were on board. After the ship has been in service for a few months the builders expect that this very economical consumption will even be reduced, as has been the case with the previous five motor ships that this firm built.

DEVICE FOR UNLOADING CARGO.—According to consular reports, the division engineer of the Canadian-Pacific Railway has just completed plans for two swinging bridges, which will be installed at one of the company's piers to facilitate unloading and loading the new steamships *Empress of Asia* and *Empress of Russia,* while taking on coal at Vancouver. These vessels are coaled from side ports, as owing to the arrangement of bulkheads and machinery it is impossible to trim the bunkers from one side. With a coal barge between the vessel and the pier the cargo hatches are about 40 feet distant from the wharf. The bridges are composed of two swinging arms of truss construction, which, when not in use, can be folded against the dock and when extended will support a heavy plank gangway on which trucks can be run, giving a straight run without an incline between the ship's tackle and the freight sheds.

Old-Time War Vessel on the Great Lakes

BY NEIL WILBER* AND LANDIS ISAACS†

In view of the fact that so many historical events are being commemorated in the present year, the ide-wheel iron warship *Wolverine,* formerly the *Michigan,* which was built in 1843 and is still in active service on the Great Lakes, should not be overlooked. One of the most famous events of the war of 1812 took place near the home port of this vessel, and the ships which played a prominent part in that war on the Great Lakes, under the command of Commodore Perry, were built and launched from the same port where this famous "old war horse" is now stationed. In fact, she herself was assembled and launched within a short distance from the place where Perry's fleet of wooden vessels was built, and occasionally she steams majestically down the harbor of her birth as stately and as warlike as any of the latest battleships, varying only in "swell" and "tonnage," but at the same time showing quite a "bone in her teeth" when under way.

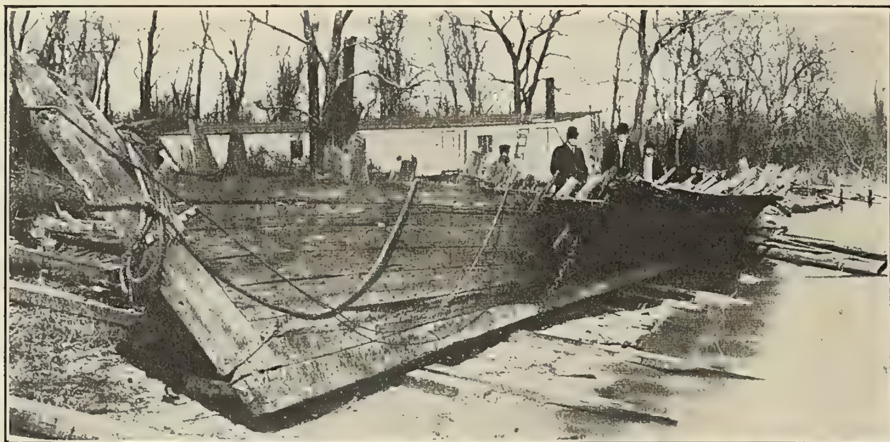


FIG. 1.—HULL OF THE NIAGARA AS IT APPEARED WHEN RAISED FROM MISERY BAY, ERIE, PA., WHERE SHE WAS SUNK ONE HUNDRED YEARS AGO
FIG. 2.—THE RECONSTRUCTED NIAGARA
FIG. 3.—VISITORS BOARDING THE NIAGARA

In calling attention to this stanch old vessel, however, mention should first be made of Commodore Perry's flagship *Niagara,* which has just been raised from the bottom of Misery Bay, where she was sunk one hundred years ago. The remarkably good condition of the timbers of this vessel can be seen from the photograph, Fig. 1, which shows the *Niagara* as she appeared when raised from Misery Bay in April, 1913. Figs. 2 and 3 show the *Niagara* as she appeared when rebuilt to take part in the Perry Celebration on the Great Lakes. At Put-in-Bay, Ohio, at the upper end of Lake Erie, near where Perry's famous battle was fought, will be erected a shaft 330 feet high, costing $500,000 (£102,500) in honor of the victory and in memory of the soldiers and sailors who where killed in the battle. With the famous achievements of these earlier wooden sailing vessels in mind, it is of interest to trace the career of the later iron steam-driven war vessel and examine her construction.

The *Wolverine* is the oldest iron side-wheel vessel afloat to-day and is in commission when the lakes are open to navigation. Until recently she was a member of the United States Navy and patroled the American boundaries of the lakes from end to end. In fact, this historic old vessel is no stranger to many of Uncle Sam's naval officers and sailors, and it is a matter of interest that the first assignment of the late Rear Admiral George W. Melville, formerly Engineer-in-Chief of the United States Navy, was on the *Wolverine,* in the early fifties.

Recently the *Wolverine* was turned over to the State of Pennsylvania for a naval training ship, to be used on the Great Lakes by the Erie Division, N. F. P. She is used in the winter as an armory where the crew is drilled regularly and taught gun and signal tactics, together with the numerous other duties which fall to the lot of a good sailor in regular service. The result of the training the men receive from the officers of the ships during the winter months is shown by the excellent scores made by the gun crews while on a practice cruise last summer with other naval ships. Gun practice is carried out on the range located at South Manitou Island in

* Ensign N. F. P., acting chief engineer.
† Formerly Ensign N. F. P. and chief engineer.

Lake Michigan. From Erie, Pa., the *Wolverine's* home port, to South Manitou Island and return is a distance of 1,350 miles, and on this cruise last summer the old vessel knocked it out in 147 hours' actual running time, averaging 9½ miles per hour, or a speed of about 8.5 knots, a performance which speaks well for the condition of a seventy-year-old war vessel.

The *Wolverine* was built in Pittsburg, Pa., in 1843, and brought to Erie by mule teams and canal boats. Stackhouse & Tomlinson built the machinery, but whether or not they built the hull is not known. She is a three-masted ship and was originally rigged for sailing as well as steaming, but now depends on steam alone. Her machinery is the most interesting feature on board and shows that our forefathers had the necessary "gray matter" and put it in proper use both in the design of the engines and in the way in which allowances were made for adjustment, etc., to the valve gear and other parts of the machinery. The following description of the hull, machinery, engines, boilers, valve gear and air pumps of this vessel will show many of the peculiarities of her construction and will give marine engineers some idea of the progress which has been steadily maintained in the field of marine engineering.

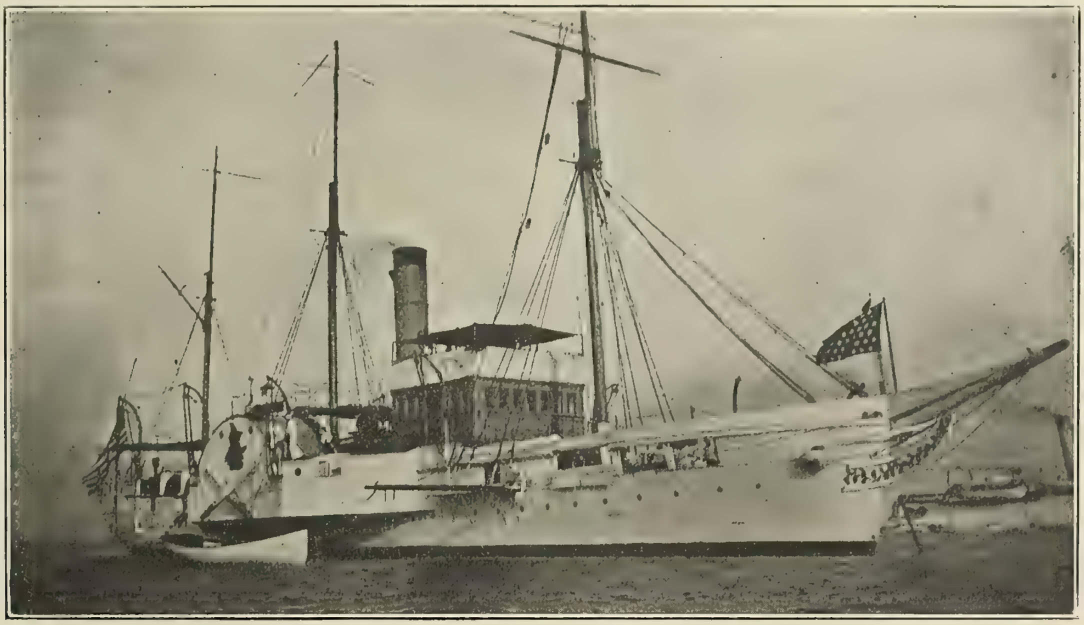


FIG. 4.—THE WOLVERINE, FORMERLY THE MICHIGAN

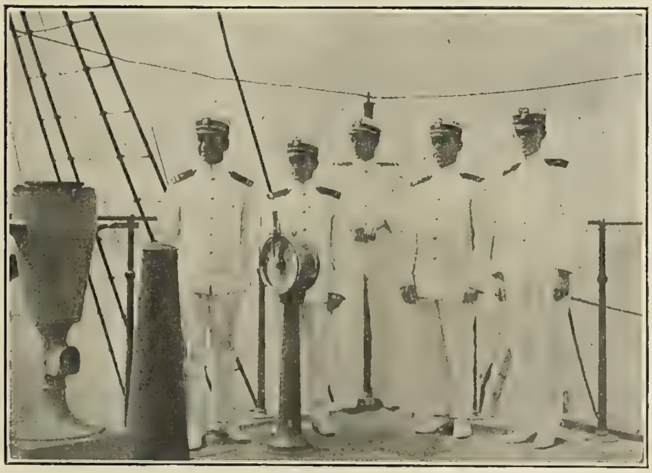


FIG. 5.—NAVIGATING BRIDGE AND OFFICERS OF THE WOLVERINE

FIG. 6.—STERN VIEW OF THE WOLVERINE

HULL AND DECKS

The hull is 167 feet long, 27 feet molded beam, 9 feet draft and 685 tons displacement, made of half-inch charcoal iron plates. The frames are 5 inches by 4½ inches and 5-inch by 3½-inch tee bars riveted together, which extend up to the main deck, with 5-inch by 4½-inch tee bars tying her together athwartship. The deck beams are also tee bars. Two steel watertight bulkheads enclose the engine and boiler rooms, which are in the same compartment amidships.

There is a berth deck, main deck, topgallant forecastle and poop deck, with a superstructure amidships. The poop deck contains the captain's quarters, the ship's library and a very interesting register of all the officers in command of the vessel while in commission.

The chart and wheel house is on the superstructure forward of the funnel. The ship is steered by hand from the wheel house, and can be handled below the main deck by a quadrant which is located under the captain's quarters, in the after part of the ward room. The forecastle is used for stowing anchors and deck tackle.

The crew's quarters are forward on the berth deck, which also contains the dispensary and mess gear. The galley is on the main deck forward of the boiler room bulkhead.

The ward room is aft of the engine room on the berth deck, being separated from the engine room by a steel watertight bulkhead. The ward room is large and roomy, as well as cozy, having accommodations for eight officers with lounging room, pantry and bath. The galley for same is on the main deck aft of the port paddle wheel box.

Directly under the ward room is located the ship's powder magazine and small arm stores, the same having to be brought up by hand through the ward room to the main deck.

The keelsons as shown on the drawings extend through the engine and boiler room, or from bulkhead to bulkhead, and are built of angles and half-inch plate. The gallows frames are built of wood entirely, and are the same as originally installed. There are two coal bunkers outboard of the engines, extending from bulkhead to bulkhead, with a capacity of 50 tons each.

The decks are 3-inch by 3-inch yellow pine calked, with all bolt holes plugged. She has three yellow pine masts with

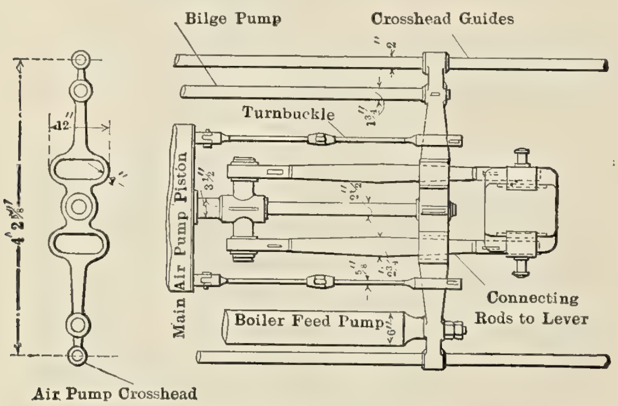


FIG. 7.—PLAN OF MAIN AIR PUMP CROSSHEAD, WITH BOILER FEED AND BILGE PUMPS ATTACHED

crosstrees, gaft and bowsprit and a full complement of boats, including two 5-ton steam cutters, a captain's gig, etc. She is also equipped with wireless and all the latest signaling devices, although for over sixty years the only lights aboard were kerosene (paraffin) lamps.

Guns

The original guns were of the old muzzle-loading type with a breeching made fast to the bulwarks to take up the recoil, but these were relegated to the scrap heap for the more modern Driggs-Schroeder semi-automatic rapid fire six pounders, there being six of them, a Colt automatic field gun, a rapid fire gun and two one-pounders for saluting purposes. Four of the six-pounders have been replaced by two-pounders of later design with telescopic sights, wind gages and night sights. The old Colts .45 revolvers have also given way to the new Colts automatic.

Engines

The machinery consists of two simple inclined engines 36-inch by 96-inch stroke, developing a maximum of 365 horsepower. The engines are coupled together.

The cylinders have dished heads and the crank end head has about half of the steam port cast in it. There is a steam chest forward and aft of both cylinders, which is divided into two compartments, one for steam and the other for exhaust, both connecting with the cylinder ports.

There are two 10-inch brass double-seated steam and exhaust valves, both being worked from one rocker shaft, the lift for the exhaust being increased by the toe on the rocker. In order for the steam to get to the after chest, it must first pass through the upper chest, then through a jacketed copper pipe, through the after chest, and into the cylinder, from whence it is returned through the after chest again and into another copper-jacketed pipe and into the condenser. The exhaust pipe joining the condenser is made of copper and is rectangular in shape.

Both steam chest and cylinder are cast iron, and are splendid castings. The cylinders, steam and exhaust pipes are jacketed with several layers of hair felt, around which is a black walnut corrugated lagging held in place with brass bands. The steam chests are not lagged at all. The crank and head end cylinder heads both bolt on to the cylinder.

Condensers

There is a jet condenser connected to each cylinder. The condensers are cross connected and each one has three connections to the sea, two in the bottom of the ship and one at the side, a little above the turn of the bilge, insuring at all times a good supply of clean water. The connections are through 3-inch copper pipes which have never been replaced since they were first installed. The sea cocks or Dutch cocks

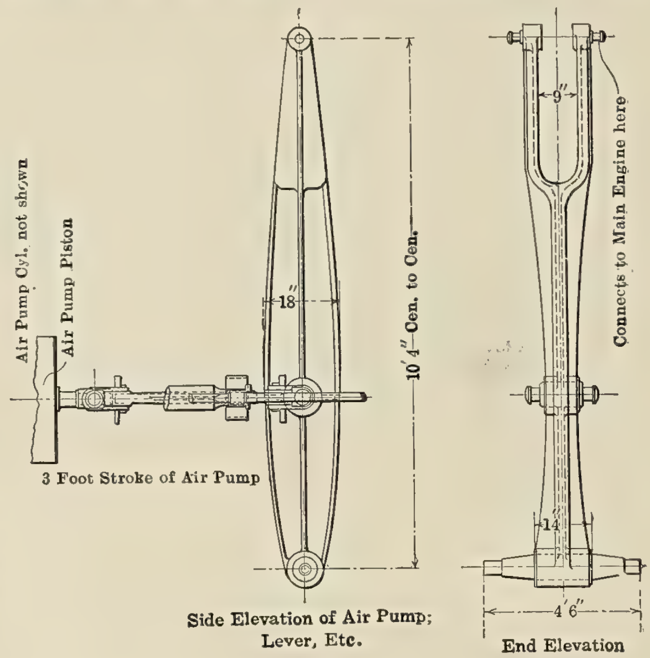


FIG. 8.—AIR, FEED AND BILGE PUMP LEVER, SIDE AND END ELEVATION

are operated through miter gears, by levers, located at the starting platform of the engines.

The condenser base, hotwell and air pump base are in one casting over 10 feet long, extending over the engine keelsons. A manhole is placed between the hotwell and condenser for entering same or inspection of valves, etc.

Owing to their great age, the condensers are very remarkable for the vacuum they maintain, the one on the starboard engine carrying 26 inches and the one on the port 25 inches as maximum, while the minimum for both is 22 inches.

Air Pumps

The air pumps have a 36-inch stroke and are of the combination type, being worked from the main engine crosshead by a cast iron lever 10 feet long, which is supported by the engine keelsons. This lever connects with a crosshead on the air pump which carries the different pump rods.

The main barrel of the air pump is cast iron, 29 inches diameter with a 1½-inch brass liner. On the inboard side of the air pump is a 6-inch brass plunger boiler feed pump, and on the outboard side is a 5-inch cast iron bilge pump. There are feet on the air pump barrel that rest in holders on the condenser base plate, which serve to hold the entire outfit together.

The air pump lever is connected to the main engine crosshead by two connecting rods with gibs, straps, keys, etc. This lever is very peculiar in its design (see Fig. 8), as the main engine connecting rod works through it at the upper end.

The crosshead, rods, gibs and straps are all polished and are in very good condition at the present time. The air pump

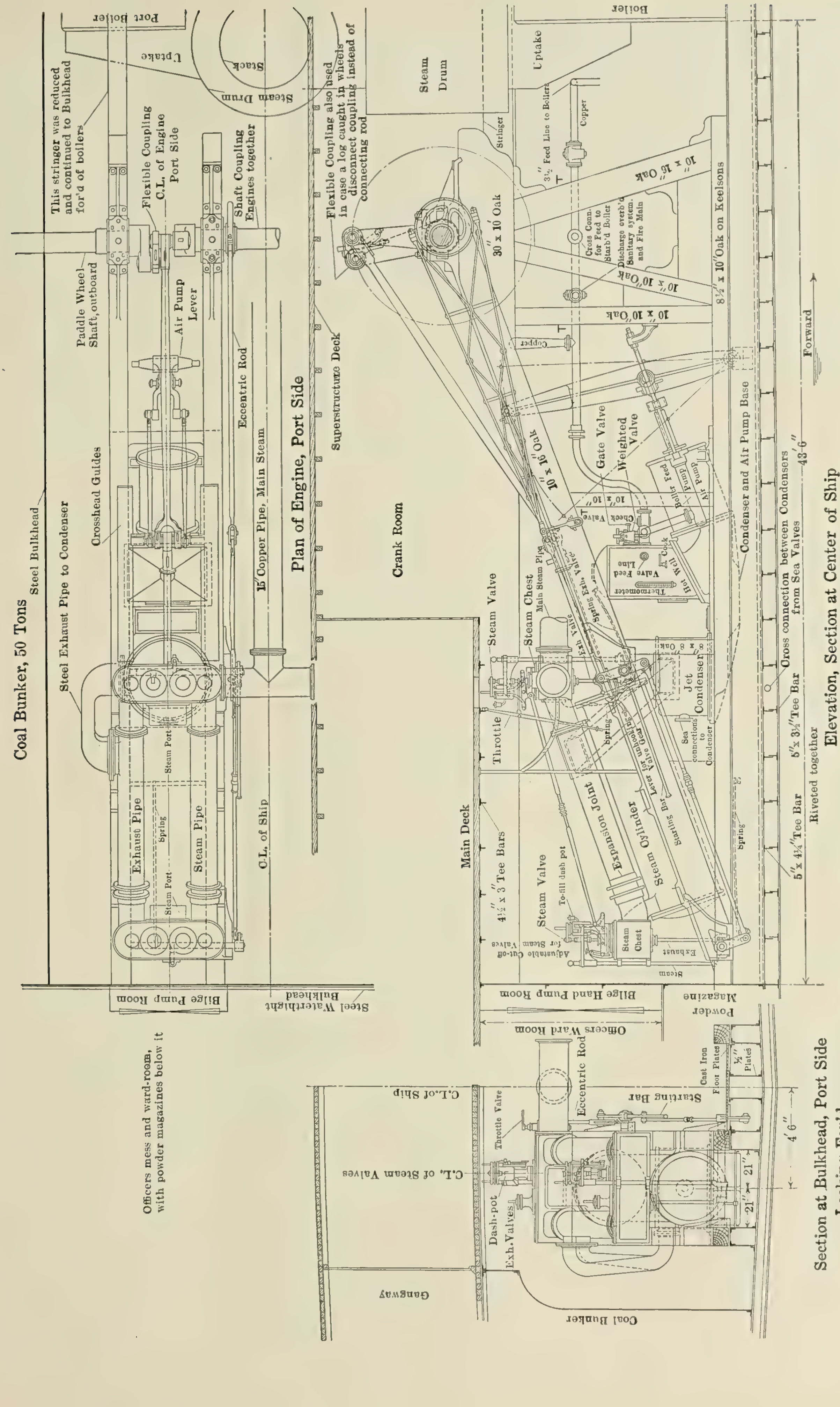


FIG. 9.—LONGITUDINAL SECTION AND PLAN SHOWING ARRANGEMENT OF ENGINE AND MACHINERY, PORT SIDE, AND SECTION AT BULKHEAD OF U. S. S. WOLVERINE

piston is made of solid brass and has two rods with turnbuckles, one on each side of the main piston rod, which allows of lateral movement and holds the piston squarely in place at all times. The air pump piston rod also has a short crosshead attached to it.

Hotwell

The hotwell is at the base of the air pump, as shown in Fig 9. The feed line is so arranged that you can feed the boilers, discharge overboard, to fire mains, and flushing system, or decks, just as the occasion requires. There is also a 3-inch gate valve to which a pipe was connected that was led all around the outside of the ship. This pipe was perforated with small holes and was used to repel the enemy in boarding by squirting hot water and steam on them. It is claimed that this was the real mission of this arrangement, although this pipe has been disconnected.

The feed line has cross connections between the boilers, also two check valves and a weighted valve at the hotwell which seems to act as an outboard delivery valve. The line is 3½-inch copper pipe and is as originally installed. It has an expansion joint and an air chamber, also an expansion bend, as shown in Fig. 9.

The hotwell is supplied with thermometer, cocks, etc., for testing the temperature of the water, and a boiler feed regulating valve, as well as a check valve at boiler.

Valve Gear

The valve gear is of the poppet type with dash-pot and adjustable cut-off. A 1½-inch by ½-inch bar connects the upper and lower together for adjusting the cut-off and is worked from the starting platform.

The steam valves are 10 inches diameter, double-seated brass valves, and are worked from toes on the rocker shafts, which in turn are worked by the eccentrics. The exhaust valves are also 10-inch diameter, double-seated brass valves, the lift of which cannot be changed except by changing the position of the arm on the rocker shaft, thereby giving a greater or lesser area of opening, as desired. The toe for the exhaust valve is very much longer than the one for the steam valve, thus giving it more opening, in order that it may discharge the exhaust steam quickly. There is an offset on the toe of the exhaust valve, so that a spring may be attached to the under side of same. This spring is similar to a carriage spring, and is made of four leaves 2 inches by ¼ inch by 8 feet long. The other end of the spring bolts to the top of hotwell. The spring on the lower gear bolts to a cross bar which is between the engine keelsons.

The object of these springs is to keep the exhaust valves closed, as the pressure in the cylinder is on the under side of them, and the vacuum is on the upper side, therefore they must be strong enough to resist the steam pressure plus the pull of the vacuum minus the weight of the valve, stem, etc. The steam valve is worked from the same rocker shaft as the exhaust valve, but not in the same manner. In this case a vertical stem or shaft with a toe passes in front of the upper steam chest, and in back of the lower chest. On the upper end of this shaft or stem is a spring bar which extends over, around, and up against the "cut-off wedges" or trips. This arm has a spring which holds it in place all the time.

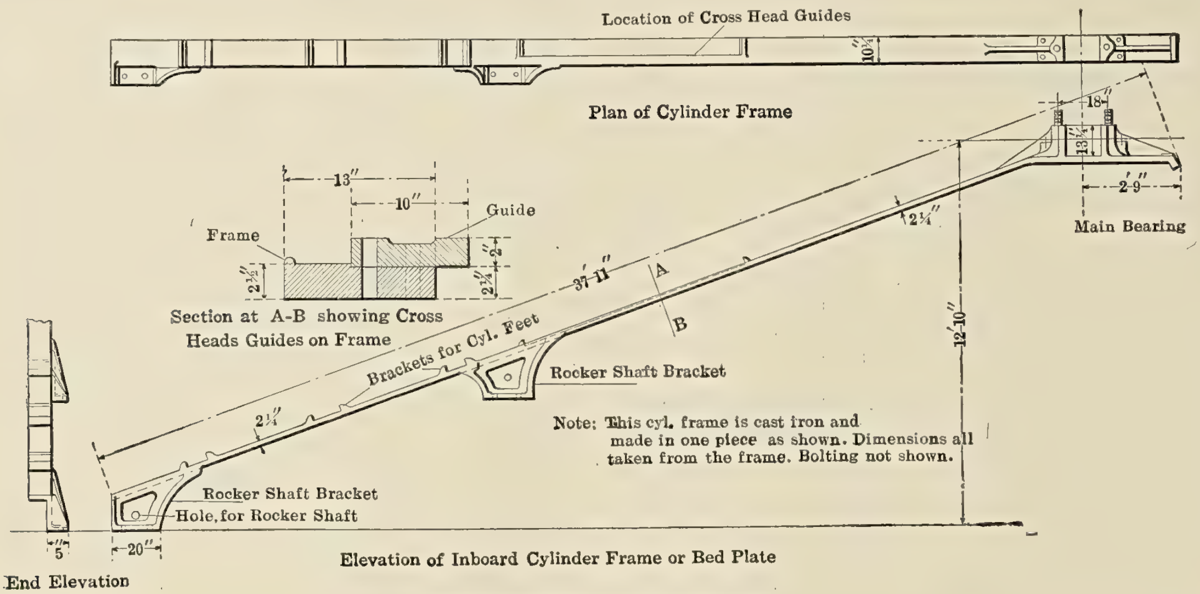


FIG. 10.—CYLINDER FRAME OR BED PLATE

Directly under this spring bar is a brass arm which is attached to the same upright shaft or stem. The dash-pot serves as a guide for this brass arm, as the other end of the arm fits a third of the way around the dash-pot, and as the shaft rises the arm also rises with it and slides against the side of it. Through this brass arm is a 3-inch hole, through which the valve stem proper works. This stem is short, the valve being on one end, and the other end is hooked to the plunger in the dash-pot. In the middle of this valve stem is a round "spool" which is screwed on and held in place by jam nuts. This spool is hardened.

The spring bar is forced in under the spool by the spring when the valve reseats, hence the valve is lifted from its seat when the vertical shaft and arm rises up, due to the action of the rocker shaft, but when the valve is lifted a certain height, or according to the cut-off being used, the arm with the spring is knocked out from under the spool, the valve drops to its seat, being relieved of shock and properly seated by the dash-pot. The arm which lifts the valve also has a hardened piece inserted which fits under the spool, as there is continuous wear on these two pieces. The lift of the valve can be adjusted in two or three different ways, as desired.

The dash-pot is cast iron finished all over, with a cup on the side for filling when necessary. It also has the necessary glands, guides, etc. The cut-off wedges are carried by means of a flat piece bolted to the dash-pot, which takes hold of the cut-off bar at the center; the wedges and radius bars are in one piece, with the wedges at the top to kick out the spring bar. These wedges are two in number, one for cutting off the steam or kicking out the spring bar, the other for keeping the spring bar off the cut-off wedge when it comes down or on the return stroke. The spring bar has two bevels that coincide with those on the wedges. The radius bar bevels or wedges serve two purposes: First, to keep the wear off the steam wedge and to prevent slam or noise when returning to its position; second, if for any reason the spring bar might stick, steam would be carried the full stroke up and down, and the valve still being open there would be steam on both sides of the piston, but if such were the case, as soon as the spring bar started on the down or return stroke, it would come in contact with the wedge or bevel for reseating the bar, and

(finished), and has a latticework eccentric rod which is about 16 feet long and is supported by a pin and connecting rod on the side of the engine frame. The eccentric is keyed on the paddle wheel shaft.

The end of the eccentric rod is solid with a bearing or pin to take the brass box and strap on the connecting rod that hooks on to the rocker shaft. This rod is very peculiar in construction and design, as will be seen by referring to Fig. 9. It flattens out at the part where the hook is, to allow it to slide along over the roller on the pin in the arm on the

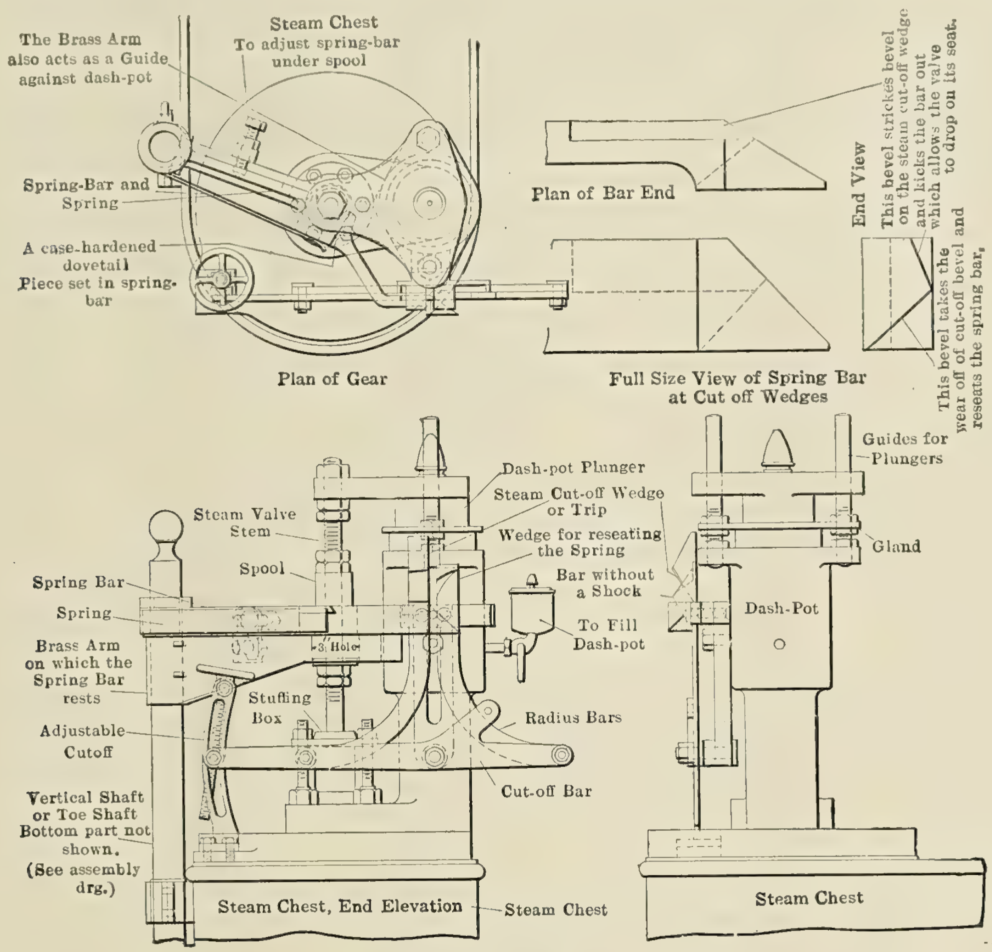


FIG. 11.—STEAM VALVE GEAR

would be "kicked out" from under the spool, allowing the valve to drop to its seat, consequently cutting off the steam at once without any mishap to the engine.

The two valve gears are connected by an adjustable rod, and when the cut-off is changed on one, it is changed an equal amount on the other, and although the gear is very complicated, it gives no trouble and makes very little noise. The plungers will rattle if the dash-pots are not kept full, and they work better after running an hour or so, as the liquid becomes heated and the valves seat quicker and more easily than they do on the start. Considering its age the gear is very remarkable and works wonderfully well.

The valve gear is operated through one eccentric only, the same being the "ahead motion." In case you have to back her, which you most surely do at times, you have to work the valve gear by hand, the same being no light job, as the starting bars are heavy and you must give her steam or lift the rocker arm at the right time or you will block her, and every marine engineer knows the necessity of having his engine under control when in close quarters, or when coming alongside of a dock.

The eccentric sheave is cast iron, the straps being brass

rocker shaft, when it is not "hooked in." To hook the eccentric in, all that is necessary is to pull down on the "Lever for unhooking valve gear," as shown in Fig. 9. The eccentric is unhooked, as shown, and to "Hook her in" you would pull down on the spring and the hook lever would fly out and the hook in the rod would fall into place, on the roller, on the rocker shaft arm, and the engines would run ahead. Of course, it would be necessary to use the starting bar and get the paddle wheels turning, and probably make a few revolutions before doing this.

Main Connecting Rod

The connecting rod is 16 feet 6 inches center to center, 6 inches diameter at center, 4 inches diameter at ends. It has a brass box, straps, keys and gibs on the crank end. At the crosshead the rod has the usual fork, with straps, keys and gibs for connecting to same. The main piston rod is 4 inches diameter and has a "bald head" on the crosshead end. This "bald head" is keyed to the piston rod with a through key and the crosshead is slipped through a hole in the "bald head," which has a brass journal in it and is held in place by the boxes in the fork end of the connecting rod.

The crosshead guides are flat cast iron slabs bolted to the engine bed plates or frame, and extend over for the guides to work on. The crosshead also works the air pump through two rods connected to the pump lever.

The main wheel shafting is 11 inches in diameter in the bearing and there are four bearings to each engine, two as shown and two that are outboard, one on the knuckle of the main deck and the other one carrying the extreme end of the shaft in the paddle box.

The paddle box is carried by a steel framework, fastened to the side of the hull and braced up with 2-inch braces, same having a palm which is riveted to the skin of ship, a little above the turn of the bilge strake. The box itself is steel with doors for entering same to oil or for inspection.

(*To be concluded.*)

McAndrew's Floating School

BY CAPTAIN C. A. McALLISTER*

CHAPTER XVII

Indicator Cards and Horsepower

"My subject this evening will be indicator cards," remarked McAndrew, as his class gathered in the improvised school room after a hard day's work in connection with lowering two of the new boilers of the *Tuscarora* in place.

"Do you know what a steam engine indicator is?" he inquired, looking at O'Rourke, who he surmised would be the first to give a reply. He was not disappointed, as that young man immediately volunteered the information that "an indicator, sir, is a nickel-plated machine that looks something like a pickle castor; you screw it into the outside of a cylinder, tie a string to its tail, let it sneeze three or four times, then unwrap a piece of paper from the outside, which you carry up to the chief engineer, who looks wise, fixes his 'specs,' and delivers the opinion that she's got too much compression, whatever that is."

"That's a fine description, O'Rourke, and shows that you are a man of keen perception, especially as to the 'look wise' part of the performance. The appearance of knowing all about it seems to attach itself to the face of every man who has an indicator card handed to him for inspection. As a matter of fact there are a great many people who look at indicator cards in this manner who don't know much more about them than any of you boys do right now. For that reason I intend to tell you something about them, so that you will not altogether belie your looks when you come to do the 'wise' act.

"An indicator, as its name implies, is used to indicate what transpires inside the cylinder. You all know that steam enters at one end of the engine and leaves at the other; but it is what it does in the meantime which interests us most.

"One of the principal features of the indicator is a small steam cylinder, which can be connected directly to either one end of the main cylinder or the other, at will, by simply turning a three-way cock. The steam acting on the piston in this small cylinder is therefore duplicating exactly its effect on the piston of the cylinder to which it is attached at every portion of its stroke. The up and down motion of this small piston is transmitted by means of a system of small levers and links to a small pencil point, which is made to move in a straight vertical line.

"The other main portion of the indicator is the barrel, which by means of a cord attached to a specially arranged reducing gear, is given a rotary motion corresponding on a small scale, of course, to the simultaneous action of the steam engine piston. Then, by pressing this pencil point, moving always in a vertical line, against a piece of paper wrapped around the rotating drum, a figure is drawn, which, to the initiated, shows exactly what pressure in pounds per square inch is being exerted on the engine piston at every point in its stroke.

"The little piston works against a spiral spring of a tension designed according to the pressure which is expected to be used in the cylinder. On the high-pressure cylinder we would use springs of from 60 to 100 pounds tension, on the intermediate from 20 to 50 pounds, and on the low-pressure a spring of about 10 pounds tension."

* Engineer-in-Chief, U. S. Revenue Cutter Service.

Here McAndrew drew the sketch (Fig. 29) on the blackboard, and said, "This represents an ideal indicator card taken from a single-cylinder condensing engine."

"Huh!" remarked O'Rourke, after the sketch had been completed, "that looks like one of those wooden shoes that Schmidt's grandfather wore."

Schmidt retaliated by remarking that he would bet that O'Rourke's grandfather was a bog-trotter, and didn't have shoes of any kind to wear.

"That'll do," suggested McAndrew. "This is no lecture on 'Shoes of All Nations.'

"This card is what you would get off a well-designed engine. The line *PQ* is known as the atmospheric line, or the line

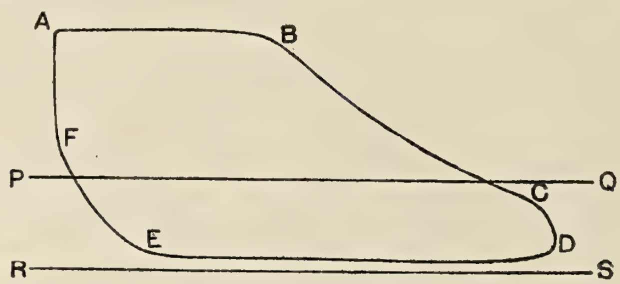


FIG. 29.—INDICATOR CARD

showing the pressure of the atmosphere. It should always be drawn on the card before making the connection to either end of the cylinder, or otherwise your card will not be of much value. The line *RS* is known as the line of zero pressure, and has to be drawn on the card with a ruler. As the pressure of the atmosphere is, as I have told you before, 14.7 pounds per square inch, it should be a distance below the atmospheric line equivalent to that pressure on the scale used for whichever tension of spring has been used in the indicator. For example, if a 30-pound spring has been used, the zero line would be about one-half inch below the atmospheric line and always parallel to it."

"What's *parallel* mean?" whispered O'Rourke to Pierce.

Overhearing the question, McAndrew said, "I am surprised that you don't know the meaning of that term. 'Parallel' means two lines that are the same distance apart at all points, like railroad tracks, for instance; they never meet no matter how far they are extended."

"Schmidt's feet must be parallel, then," interjected O'Rourke. "He' so bow-legged that they have never met yet."

"Now referring to the figure again," McAndrew continued, "you all know that the steam is admitted to the cylinder at the end of each stroke almost instantaneously as the valve opens; this causes the pencil point to go up almost vertically as the revolving drum, following the motion of the engine piston, is then practically at a standstill while changing direction. This line *AF* on the card is known as the admission line; as the valve remains open the steam continues to rush in at the same pressure, thus making the line *AB* practically parallel to the atmospheric line. This line *AB* is known as the steam line. *B* is the point of cut-off, where steam can no longer enter the cylinder direct from the boilers. The point of cut-off varies from .3 to .7 of the stroke, according to the various conditions.

"After the valve closes, the steam in the cylinder continues to shove the piston on its travel by the expansive force of the steam. As the piston proceeds on its stroke the pressure of the steam gradually drops, so that the line traced by the pencil assumes a curved shape as shown in the diagram; this line *BD* is known as the expansion line. At the point *D* the valve opens to the exhaust, and the steam rushes out of the cylinder."

"Do they call it 'exhausted' because the steam is tired out from pushing the piston?" inquired O'Rourke.

"Very likely that's the reason," smilingly replied McAndrew.

"The live steam is now being admitted to the other end of the cylinder driving the piston on its return stroke, and the expanded steam, or 'tired' steam, as O'Rourke thinks it is, continues to escape from the opposite end until suddenly the valve closes at the point *E* in the stroke, and a certain amount of this 'tired' steam is imprisoned in the cylinder. As the piston has not yet finished its stroke this portion of the exhaust steam is compresed in the cylinder, and acts as a spring to overcome the momentum of the piston when it reaches the end of the stroke. It thus acts very much like a bumper on a freight car. At the point *F* live steam is again admitted to that end of the cylinder, and the operation, which I have outlined, is repeated.

"The card which I have shown you is, of course, for only one end of the cylinder; the card from the other end will be of the same general shape, and the pair will look like Fig. 30":

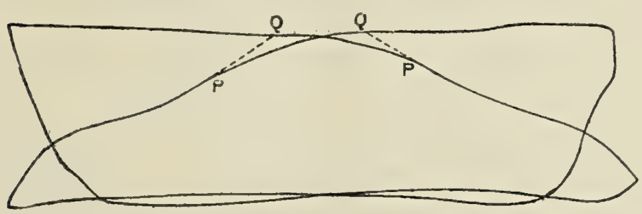


FIG. 30.—PAIR OF INDICATOR CARDS

"That looks like a pair of wooden shoes on a pigeon-toed man."

"What good are all these indicator cards?" inquired Nelson.

"That's the point I am coming to," replied McAndrew. "They are not of any use unless you can read them intelligently. An indicator card to a trained engineer serves about the same purpose as counting the pulse, taking the temperature and looking at the tongue of a sick man does to a physician. You find out what is going on inside. If there is anything wrong with the valves, or if the piston is leaking, it is shown at once on the card. The principal value of a card is, however, to tell how much power is being developed by the engine, and how it is distributed among the cylinders of a multiple-expansion engine.

"Here are some of the examples of wrong valve setting which can be detected.

"All eccentrics of a Stephenson link motion valve gear, the one most universally used in marine work, are set at right angles, or one-fourth of the circumference of the crank circle in advance of the crank, plus a small angle known as the angular advance. Now if this angular advance is too large, cut-off occurs too soon, the steam lead, or time the valve is open before the piston reaches the end of the stroke, is too great, and the opening and closing of the exhaust occur too soon; in other words, all of the functions of the valve are ahead of time, and the result is shown by a card such as I have shown in Fig. 31.

"If, on the contrary, this angular advance is too small, then all of the functions of the valve are too late, and the resulting card will be like Fig. 32.

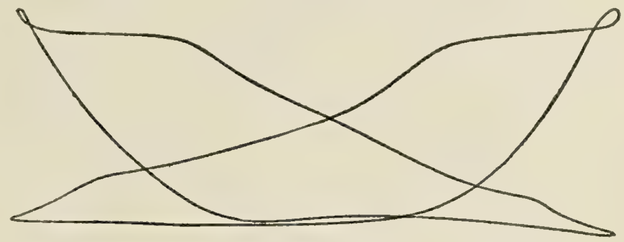


FIG. 31.—INDICATOR CARDS, WITH ANGULAR ADVANCE TOO LARGE

"The steam lap of a valve is, as you have been told before, the amount the valve laps over the steam port when the valve is in its mid-position; the general effect of such a condition is that the cut-off is too soon, the steam opening is late, and as there is not sufficient opening for the entrance of the steam, there is a certain amount of wire-drawing or the effect of passing steam through a contracted opening. This is also indicated by a drop in the pressure, which makes the steam line get away from its parallel position to the atmospheric line. Such a state of affairs produces a card like Fig. 33.

"The opposite effect is caused in all the functions of the valve if the steam lap is too small, as shown by a card like Fig. 34.

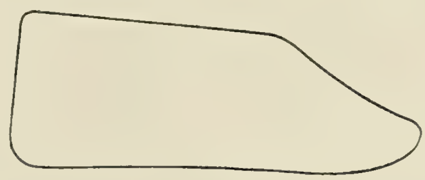


FIG. 32.—INDICATOR CARD, WITH ANGULAR ADVANCE TOO SMALL

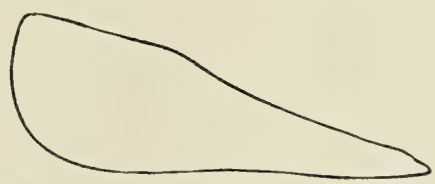


FIG. 33.—INDICATOR CARD, WITH STEAM LAP TOO LARGE

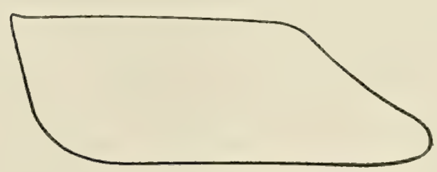


FIG. 34.—INDICATOR CARD, WITH STEAM LAP TOO SMALL

"In the layout of the valve gear the designer may have made the valve stem too long; this would result in too much steam lap on top and too little exhaust lap on the bottom, which would make the cut-off too early at the top and too late at the bottom, the steam opening on top late and at the bottom too early. Such a contingency would produce a card like Fig. 35."

"That looks as if somebody had given it a swift kick," said O'Rourke.

"Exactly so," replied McAndrew. "And if the valve stem was too short it would look as if it had received a swift kick at the other end.

"Now if the piston was leaking badly the result would be very noticeable on the expansion line, as it would not be so full as it is when the piston is tight and the steam is expanded normally. In other words the expansion line would drop below

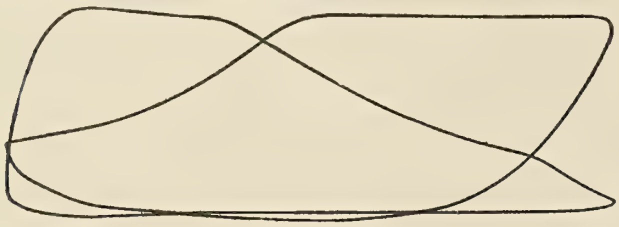


FIG. 35.—INDICATOR CARD, WITH VALVE STEM TOO LONG OR TOO SHORT

its right position on the card, showing that the pressure was low on account of the leak.

"There are many other conditions that are shown by the shape of the indicator cards, most of which can be reasoned out by understanding the general conditions affecting the steam in the cylinder. As your experience in reading indicator cards progresses you will be better able to interpret the conditions which exist.

"We now come to the calculation of horsepower from the indicator diagrams. You will remember that in the early days of this Floating School I tried to impress upon you the meaning of power; that is, that it consists of three elements—force, in pounds; distance, in feet; and time, in minutes.

"The element of distance is quite easily determined, as knowing the stroke of the engine in inches, we can, by counting the revolutions and multiplying that number by two (as it takes two strokes to make a revolution), quite easily determine how far the piston has traveled in any given time.

"The element of time is readily determined by observations on the engine-room clock or on a watch held in the hand.

"The third element, of force exerted in pounds, is more difficult to determine, and is the only essential in the calculation which is furnished by means of the indicator card. We know that the steam enters a cylinder at a little less pressure than shown by the boiler gage, and that it leaves at a greatly

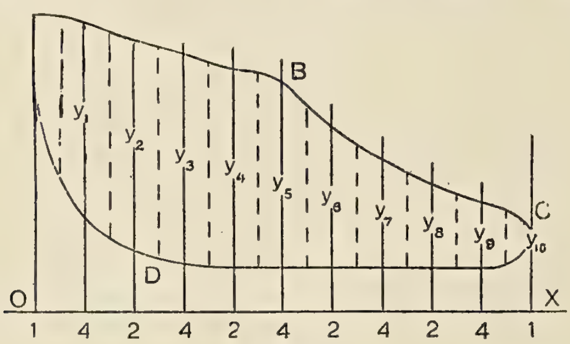


FIG. 36

reduced pressure. When we have different pressures at every point of the piston's travel, in order to determine the total pressure exerted we must take the average of all the pressures. This is where the indicator card comes into use, as from the scale of the spring used it is possible to determine the pressure exerted at every point of the stroke. To get the average pressure from an indicator card the simplest method is as follows:

"Divide the card into ten intervals, as shown by y_0, y_1, etc. Between each of these spaces draw dotted lines just half-way between the full lines. Now add up the lengths of all these ten lines, either by measuring each one separately or transferring them one after another to a strip of paper; divide the total length of all these dotted lines by 10, and the answer, multiplied by the scale of the spring, will give you the average pressure exerted on the piston.

"Another method is by what is known as a planimeter, a small instrument which usually comes with every set of indicators. By this instrument we can ascertain the area of any irregular figure. We can easily measure the length of the card, so by dividing the area in square inches by the length in inches, the quotient will give us the average height, also in inches. This height, multiplied by the scale of the spring, gives the mean or average pressure.

"Having ascertained the mean pressure per square inch, the next step is to find out the total pressure on the piston. The rule for the area of any circle is to square the diameter; that is, multiply it by itself, and then multiply that quotient by the figures .7854, which gives the area in square inches. Knowing the pressure per square inch and the total number of square inches in the piston, we multiply them together to find the total pressure in pounds on the whole piston, which is, as I told you, the last of the three elements necessary in calculating horsepower."

"What has 'drawing' got to do with figuring horsepower?" inquired O'Rourke.

"I don't quite understand you," said McAndrew.

"A guy out here in the shipyard told me only this morning that all you had to do was to remember the word 'drawing' and you could figure horsepower," argued O'Rourke.

"Oh! I see what you are driving at. You mean the word P-L-A-N, not drawing. That word has been connected with the subject ever since horsepower was invented. It is a good way to remember the calculation, providing you know what the letters signify.

P means the average pressure per square inch; *L* stands for the length of stroke; *A* is the area of the piston; *N* is the number of revolutions.

"It is much better to remember the method, however, by reasoning the matter out in terms of force, distance and time, as I have already told you. We want to get the whole problem into so many foot pounds per minute, then we know that dividing by 33,000 will give us the horsepower. The best way to illustrate the method is to work out a specimen for you. For example:

"A certain steam cylinder is 41 inches in diameter, the stroke is 36 inches, the mean effective pressure is 42 pounds per square inch, and the number of revolutions is 110 per minute. What is the horsepower?

"We find the area of the piston as follows:

41
41
——
41
164
——
1681
.7854
——
6724
8405
13448
11767
——
1320.2574

"Now multiply the area by the mean effective pressure

1320.25
42
——
264050
528100
——
55450.50

"This gives us the total pounds pressure exerted on the piston and is the element of *force*.

"The distance the piston moves through is, of course, equal to twice the stroke, as the piston has to go up and down to make one revolution, therefore as 36 inches is equal to 3 feet, multiply by 2, and we have 6 feet as the distance moved in one revolution, and in 110 revolutions it will have moved 660 feet—this is the element of *distance*.

"The element of time is, of course, one minute, as that is the basis on which horsepower is taken.

"Now multiply the force (55450.5 pounds) by the distance (660 feet), and we get 36,597,330 foot pounds per minute. Dividing this number by 33,000 we find the answer to be 1109 horsepower. The calculations I have shown you would be all right if there were no piston rod; but as that is, of course, a necessity, we must make allowances for the area of the rod, as no pressure is exerted on that portion of the piston occupied by the rod. I should also tell you that in making the calculations the mean effective pressure per square inch must be taken as the average obtained from the top and bottom indicator cards.

"To allow for the piston rod it is customary to calculate its area the same as for any other circle, and to take only half the area of the rod from the total area of the piston, as the rod is, as you know, on only one side. Thus the area of a piston rod 6 inches in diameter is 28.274 square inches. One-half of that is 14.137 square inches. This should be subtracted from the total area of the piston 1320.25, which would leave 1306.11 square inches to be multiplied by 42 to obtain the element force, average or total pressure on the piston."

"Chief, what's the use of all this 'dope' about indicator cards and horsepower to the men that drive the engine?" asked Pierce.

"I don't suppose that it is very valuable to the ordinary everyday engine-driving man on board ship, but engineers are somewhat like lawyers in this respect. Every lawyer likes to study about the Constitution and be admitted to practice before the Supreme Court. About one in every hundred ever has occasion to use his knowledge in that connection, but he would be a poor lawyer if he didn't aim that high."

(*To be continued.*)

November Storm on the Great Lakes

The gale which swept the Great Lakes on Sunday, Nov. 9, continuing well over Monday, Nov. 10, although decreasing in violence toward the close of the day, was marked with a greater loss of life and property than any single storm on record. At least 250 lives were lost, while the property loss runs into millions. No less than nine large steel steamers foundered outright in the open lake, while in addition to these a number of ships sustained serious damage through grounding or by being blown ashore.

On Lake Superior the *Henry B. Smith*, 525 feet by 55 feet by 31 feet, and the *Leafield*, 249 feet by 35 feet 3 inches by 16 feet 6 inches, foundered outright in the open lake, and on Lake Huron the *Charles S. Price*, 504 feet by 54 feet by 30 feet; the *James Carruthers*, 529 feet by 58 feet by 31 feet; the *John A. McGean*, 440 feet by 52 feet by 28 feet; the *Wexford*, 250 feet by 40 feet by 16 feet 7 inches; the *Hydrus*, 416 feet by 50 feet by 28 feet; the *Argus*, 416 feet by 50 feet by 28 feet, and the *Isaac M. Scott*, 504 feet by 54 feet by 30 feet, met with a like fate. The list of the most seriously damaged vessels included the *Motoa, Acadian, H. A. Hawgood, L. C. Waldo, D. O. Mills, William Nottingham, Hartwell, J. T. Hutchinson, Turret Chief, Henry M. Hanna, Regina* and *Northern Queen*.

Inadequate Warning by the Weather Bureau

Considerable criticism has been leveled at the United States Weather Bureau for alleged failure to warn vessels properly of an impending violent storm. The weather report on Saturday, Nov. 8, which was predicted for a period ending at 7 P. M. Sunday, was as follows:

For the Upper Lakes: "High west and northwest winds, diminishing to-night on West Superior. Snow flurries and colder to-night. Sunday, generally fair."

Some mariners claim that this warning is entirely inadequate, and that similar warnings are received for practically every blow which crosses the Lakes. Coming upon the admission of the weather bureau that this storm was a so-called "break," as it doubled back upon itself after having passed the Lake region, it would seem that special effort should have been used to warn Lake vessels passing or leaving port. The local office at Detroit claims to have given ample warning to all vessels passing after Friday morning, Nov. 7, by a special report delivered to them at the Marine Postoffice. The regular reports followed with a weather map attached. Cleveland men claim that all the report they received was "Snow and colder, with winds." It should be remembered, however, that any storm approaching a hurricane in the strict sense of the word is unusual upon the Lakes, and presumably for that reason no hurricane signal is ever displayed at night. Consequently it would seem that in most cases it was up to the individual vessel master to judge the probable severity of the storm, a condition which perhaps should be remedied.

Another point that should be borne in mind is that the peculiar atmospheric conditions existing in the Lake region are a very uncertain proposition, and the task of the weather bureau to give accurate and timely warnings in this district is no small one.

Seaworthiness of Lake Vessels

Turning, however, to the results of the storm and the unusually large number of modern steel ships that were lost, the opportunity for criticism upon and inquiry into the seaworthiness of Lake vessels is admittedly great. It must be remembered, however, that Lake vessels are built for a highly specialized trade, and are therefore subject to some governing conditions which render them apparently much weaker than they should be if compared with the usual types of construction found in sea-going ships. Furthermore, the maximum wave lengths on the Lakes are much shorter than on the ocean, and this permits differences in construction, so that in summing up the principal causes for so many founderings in this storm, one feels constrained to lay it to the shifting of cargo, as that puts the ship in a very bad trim to withstand the sea effectually.

It is a well recognized fact that the bulk cargoes carried in Lake vessels, particularly iron ore, are peculiarly liable to shifting; and although the exact reasons and conditions surrounding the foundering of these ships will never be known, nevertheless, previous experience would seem to show that shifting cargo is responsible for many Lake losses.

The argument will probably be advanced that proper trimming of cargo would obviate this danger. This is perhaps true, but again come in the special conditions existing on the Lakes. While trimming a cargo is by no means an impossibility, still the loading conditions sometimes make it very difficult, to say nothing of causing great loss of time at the docks. When it is considered that the average Lake run with a single cargo is of only 70 to 80 hours' duration, the element of time must be reckoned with.

Comment is often made that the engine and boiler power of Lake vessels is too small for the size of the ship, particularly when severe weather conditions are met with. While there is a very good reason for installing such small power it must be admitted that in a particularly violent blow it is no uncommon thing for a vessel to blow around; that is, to fall off before the wind into the trough of the sea. This is particularly true if the vessel is in water ballast, with a sea heavy enough to cause it to pound, resulting in a loss of headway and permitting the wind to get in its work. It can be easily understood that once in the trough of the sea it is sometimes almost impossible to bring a ship back head up. With several hundred feet of deck exposed to the sea, cut up by 9 or 12-foot hatches spaced every 12 or 24 feet, the chances of total loss are great. In addition to this fact the Lake vessel seldom has sufficient sea room, and a lee shore often looms up all too soon, so that a large number of ships are literally blown ashore.

The general design of Lake vessels is for a special trade, the demands of which are met beyond any possibility of competition, although perhaps the ship, as a type, has some drawbacks in heavy weather. The fact must not be lost sight of, however, that among the ships lost four were of foreign build, and of these only one was built for the Lake trade in every sense of the word. These vessels were the *Leafield, Wexford, Turret Chief* and *Regina,* the last named being the only ship built for the Lake trade.

Wreck of the Charles S. Price

One very peculiar wreck might be mentioned here, and that is the wreck of the *Charles S. Price*. This ship apparently turned back after having gone up Lake Huron some 60 odd miles from the head of the St. Clair River at Port Huron, and she now lies about 13 miles from this place. When the ship was first sighted on Nov. 10, she was lying apparently upside down, with about 100 feet of her hull forward showing above the water, and her stern resting on the bottom in about 60 feet of water. At this time the 20-foot mark on the bow showed plainly, and she gradually settled below the water, until at 9 A. M. on Monday, Nov. 17, over one week from the date of her capsizing, the hull disappeared from sight. It is presumed that air trapped and contained in her hold supported the ship until the gradual release of this air through leakage allowed the ship to sink. This wreck, even upon the Lakes, is a very unusual one, but so far no other theory has been advanced as to the cause of such a condition. Even that must be admitted as a very strange occurrence for a steel ship over 500 feet long.

Summary

Summing up the situation, however, it must be admitted that the Lake ship, with comparatively small power and with a long deck, practically all given over to cargo hatches, has a very bad chance if caught under the conditions enumerated above, particularly if shifting of cargo takes place to windward, and the ship lays in the trough of the sea for any length of time, exposing her hatches to the power of the sea.

Motor Towboat Breakwater

A powerful motor towboat, christened the *Breakwater,* was built recently by the Greenport Basin and Construction Company, Greenport, N. Y., for the Breakwater Company, Hilo, Hawaiian Islands. The boat was built in knock-down form, and together with all equipment and fittings except the planking, decking and joiner sheathing, was crated and shipped by lighter to New York, where it was loaded on an American Hawaiian steamer and transported (by rail across Mexico) to Hilo. The entire shipment consisted of several hundred packages and crates.

At Hilo the erection of the vessel was supervised by Mr. Theodore W. Brigham, president of the Greenport Basin and Construction Company. Laboring under severe handicaps of weather conditions, Japanese labor and delays in receipt of certain shipments, the hull was launched March 3, 1913. The machinery was installed and passed inspection on April 7.

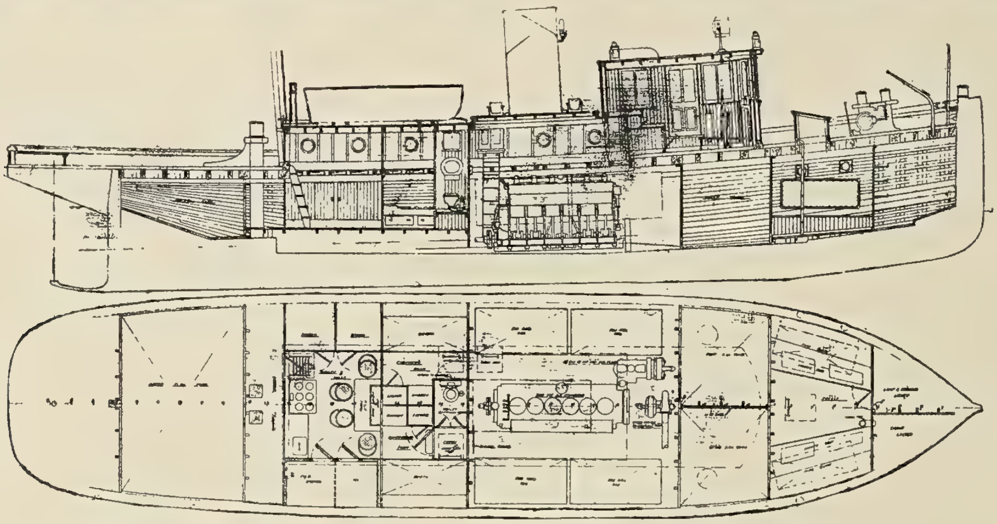


FIG. 1.—GENERAL ARRANGEMENT OF MOTOR TOWBOAT BREAKWATER

The *Breakwater* is 75 feet long overall, 18 feet beam over guards, 8 feet 6 inches depth at side amidships, with a designed displacement of 65 tons on a draft of 5 feet forward and 6 feet 6 inches aft. When finally completed and placed in commission with 700 gallons of distillate and 2,000 gallons of water divided equally fore and aft, she drew 5 feet 4 inches forward and 7 feet aft.

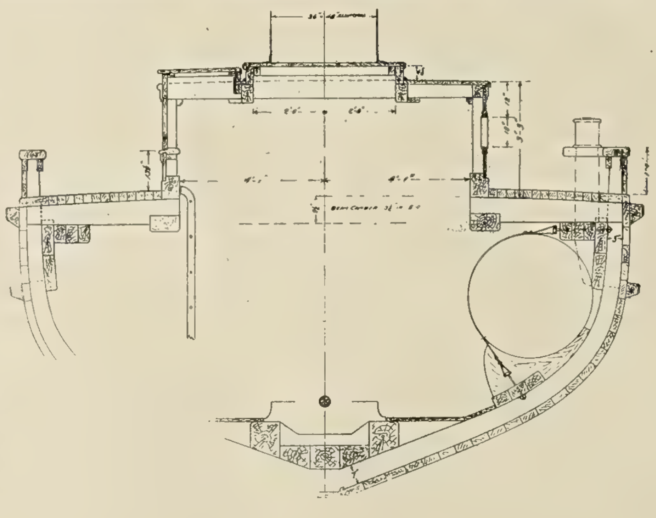


FIG. 2.—MIDSHIP SECTION

The hull is ruggedly framed, with oak keel, deadwood, stem, shaftlog and stern framing, yellow pine keelsons, bilge keelsons, clamps and shelving. The planking is 2½ inches thick and the decking 3 inches thick, with oak planksheer, top timbers, rails and monkey rails. The framing is double sawn of oak, 4-inch sided and molded 7 inches at the heels and 5 inches at the head. The deck beams are yellow pine 4 inches by 10 inches, with strong beams 10 inches by 10 inches.

Water tanks of 2,000 gallons capacity forward and 1,500 gallons aft are built in holds of 3-inch California red cedar laid Japanese fashion, without calking—a construction that proved absolutely tight.

Accommodation is provided for the captain in the pilot house, the engineer in the port stateroom, and the cook and two deckhands in the fo'csle, where four pipe berths are fitted.

The deck outfit consists of a Hyde tugboat hand windlass for ¾-inch stud link chain, a 2-inch anchor davit, watertight deck scuttles to watertanks, and brass filling plates to fuel tanks, together with the necessary tow boat equipment and deck fire hose connections. The hull up to 8 inches above the designed waterline, including the rudder blade, is sheathed with 18-ounce copper.

The propelling machinery consists of a 300-horsepower, six-cylinder, single-acting, reversing, Standard engine, fitted with the makers' shafting and bearings and connected to a three-blade bronze Hyde propeller, 60 inches diameter by 54-inch pitch. The engine revolutions range from 250 to 275 revolutions per minute, according to the fuel used. Reversing is accomplished by compressed air from storage tanks supplied by a 5 horsepower Standard auxiliary set, which is an integral unit comprising air pump, fire and bilge pump and dynamo.

The exhaust is up through the ventilating stack, which has baffle plates to deflect the rain. There are four fuel tanks of 500 gallons capacity each, 3 feet 6 inches diameter by 7 feet long, built of No. 10 gage open hearth steel, which have manhole plates for cleaning and inspection. The fire, bilge and ballast system is piped with a control manifold in the engine room to give suction and discharge at will from the sea, fresh water tanks, fo'csle bilge, machinery space bilge, overboard and fire hose connections on deck.

Electric lighting is on a 110-volt system, the current being supplied direct from a 1½ kilowatt dynamo on the auxiliary set through a switchboard in the engine room to the searchlight, running and riding lights, and lamps throughout the ship.

The operation of the vessel proves most practical by carrying one tank of gasolene (petrol) and three of distillate, changing from the former to the latter when settling down for a steady run. The operation of reversing, checking, etc., is absolutely certain under gasolene (petrol) but not positive under distillate. The above proportion of fuel represents the average amounts so far used. When running without a tow the speed and freedom from wave-making risistance, indicated especially by the absence of the deep depression usually shown alongside of a tug when speeded up, bears out the care in the design of the underbody, and the upper works show a long parallel side for ease of handling side tows, which also makes for full deck ends and an exceptionally fine sea boat. Considerable attention has been attracted by the installation of internal combustion engines in tug boats of this size and power, as with a steam installation it would be impossible to approach her arrangement of quarters, radius of action, water tank capacity, speed in light condition, and it would be difficult to equal her on tow rope pull.

French Liner Lutetia

The largest and speediest Franch merchant vessel to operate between France and South American ports is the *Lutetia*, which has been built by the Chantiers de l'Atlantique, St. Nazaire. This vessel is the second French liner to be propelled by screws actuated by combination machinery, consisting of triple expansion engines and Parsons reaction turbines. The keel of the vessel was laid June 18, 1912; she was launched March 22, 1913, and left the builder's yards for her trials on Oct. 16. Her maiden voyage from Bordeaux to South American ports will begin Nov. 29.

NEW FRENCH LINER LUTETIA, OF 14,500 GROSS TONS AND 20.5 KNOTS SPEED, FOR SERVICE TO SOUTH AMERICA

The dimensions of the vessel are as follows: Length overall, 599 feet 5 inches; breadth, 64 feet 2 inches; depth to main deck, 44 feet 1 inch; draft, 23 feet; displacement, 15,500 tons; gross tonnage, 14,500 tons; indicated horsepower, 20,000; designed speed, 20½ knots.

The entire hull, including the upper works, is built of Siemens-Martin steel. The double bottom, having a capacity of 1,650 tons of water, has been worked from end to end and is divided into ten watertight compartments. The hull itself is divided by transverse bulkheads into 12 watertight compartments, while the boiler room is further subdivided by three longitudinal bulkheads. The watertight bulkheads are pierced by 23 watertight doors which are operated by hydraulic power, controlled from the navigating bridge. In case any compartment becomes flooded, water may be discharged overboard by pumps having a total capacity of 500 tons per hour.

There are seven steel decks in the ship, three of which have been worked from end to end. Numbered from the top, they are designated as A, B, C, D (main deck), E, F and G. Above the A, or boat, deck is a large deck house containing the officers' quarters, while above this is the navigating bridge and chart house. The navigating bridge is about 55 feet above the load waterline.

The forward part of B deck is arranged as an observation room, with the front and sides, for a length of about 90 feet, fitted with thick panels of glass, which provide excellent shelter and enable the passengers to have a good view of the sea in any kind of weather. This is used as a promenade deck for the first class passengers only. In the large deck house on the B deck is the first class social hall, library, bookseller's shop, stationery office, entrance to the first class accommodations and elevators, while aft is the smoking room and an open café.

The C deck is also reserved for the first class passengers, containing de luxe staterooms, a dining room, special restaurants, a children's playroom and other special features. In all, there are 154 first class staterooms, which are distributed on the C, D and E decks. Astern, in a large deckhouse, is the second class social hall and smoking room, while on the next deck below is the second class dining room, with the main entrance to the second class accommodations.

Both ends of the main, or D, deck are devoted to the third class and steerage passengers, while amidships are located some of the first class staterooms and the second class dining room. On the E deck, or first 'tween deck, are additional first class accommodations, as well as forty staterooms for the second class passengers. Both the F and G decks are devoted to the third class passengers, their dining room being on the F deck. The steerage passengers are also berthed on these two decks. Amidships, in way of the machinery spaces, are accommodations for the engineers and firemen.

Eighteen cylindrical three-furnace boilers, located in three separate boiler rooms, and working under Howden's system of forced draft, supply steam at a pressure of 200 pounds per square inch. Each boiler room has a separate funnel 115 feet in height above the grate bars and 10 feet in diameter. The total grate surface is 1,205 square feet, and the heating surface 46,930 square feet, making a ratio of grate area to heating surface of 1 to 42.

The ship is propelled by four propellers, the inner propellers being driven by triple expansion four-cylinder engines with cylinders 41, 57, 65 and 65 inches in diameter, respectively, with a stroke of 44 inches. When running ahead, each of these engines exhausts into an independent Parsons reaction turbine, which drives a wing propeller. The engines have been designed for a total of 20,000 brake horsepower. All of the propellers are four-bladed, the inner screws having a diameter of 16 feet 5 inches and a pitch of 23 feet, while the wing propellers are 6 feet 7 inches diameter and 6 feet 7 inches pitch. Under full load the service speed will be 20.5 knots.

The main engines are located in a single compartment with the auxiliaries in a separate compartment.

Towboat Charles P. Greenough

The Portland Company, of Portland, Me., completed and delivered to the Commercial Towboat Company, of Boston, Mass., on Oct. 31, the wooden towboat *Charles P. Greenough* illustrated on this page. The principal dimensions of the boat are as follows:

Length over all	144 feet 8 inches
Molded beam	26 feet 2 inches
Depth of hold	16 feet
Maximum draft with coal, water, etc.	14 feet 5 inches
Displacement	665 tons
Gross tonnage	296 tons
Net tonnage	145 tons
Capacity of coal bunkers	160 tons
Capacity of fresh water tanks	7,500 gallons

Steam is furnished at a pressure of 175 pounds per square inch by a single-end Scotch boiler, fitted with three 44-inch Morison horse-collar type furnaces. The mean diameter of the boiler is 14 feet 4 inches, and the length over all 12 feet 7⅛ inches. The total heating surface is 2,722 square feet and the grate area 82.35 square feet.

TOWBOAT CHARLES P. GREENOUGH, BUILT BY THE PORTLAND COMPANY, PORTLAND, ME., FOR THE COMMERCIAL TOWBOAT COMPANY, BOSTON, MASS.

The engine is of the triple-expansion type with attached air pump driven from the low-pressure crosshead. The cylinders are 15, 24, 40 inches diameter, with a common stroke of 30 inches. The high and intermediate valves are of the piston type, while the low-pressure cylinder is fitted with a flat slide valve. At 120 revolutions per minute and with 175 pounds steam pressure the engine develops 900 horsepower.

The propeller is a four-bladed cast iron sectional wheel, 9 feet 8 inches diameter and 13 feet 6 inches pitch, designed to give the boat a speed of 12.6 knots.

The auxiliaries include an independent surface condenser. The feed water is heated in a filter box by 1½-inch and ½-inch Schutte & Koerting jet apparatus, the 1½-inch connection taking exhaust steam and the ½-inch connection live steam from the boiler.

The electric equipment consists of a 7-kilowatt General Electric 56-ampere, 125-volt turbine generator, with a Portland Company switchboard and also a Portland Company telltale board located in pilot house. The pilot house is further equipped with an engine-room telegraph, operated from both the starboard and port sides, and a Rushmore 18-inch type "D" pilot-house projector. The steam steering engine, which is of the Hyde make, is located aft. The ship is also equipped with a Hyde windlass and a Hyde steam hawser engine.

Letters from Practical Marine Engineers

Incidents Relating to the Design, Care and Handling of Marine Engines, Boilers and Auxiliaries; Breakdowns at Sea and Repairs

Broken Bottom End Bolt

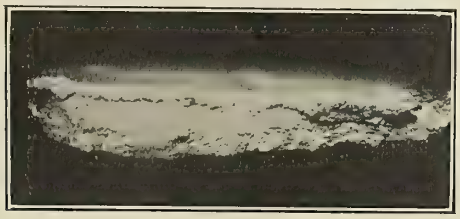
A paddle steamer was taking a pier, and on increasing the speed from slow to full speed ahead a noise was heard, which on examination proved to be due to the fracture of the bottom bolt of the crankpin brass on the high-pressure connecting rod. The bolt broke off at a point on the threaded portion just below the nut, and was obviously due to bad material, only about a quarter of an inch of the bolt remaining sound. To all appearances the flaw was a very old one.

As no spare bolts were on board, and the steamer being only about half an hour's journey from her destination, it was decided to sail her down under the single bolt. The chief engineer did not, however, deem it advisable to put the engine astern, but kept her going ahead dead slow. When giving the engine steam he was also careful to see that the high-pressure engine was on the out-stroke, so that the load would come as much as possible on the connecting rod and not upon the single remaining bolt.

The steamer eventually arrived at her destination safely and the bottom end of the connecting rod was taken adrift, when it was found that on testing the remaining bolt with a straight-edge it was perfectly true and also had not developed any cracks after its unusual experience. I. S. N.

A Condenser Overhaul

The cylindrical condenser of a certain side-wheel steamer was found to be leaking badly, which on examination proved to be due to a large horizontal crack near the top of one of the tube plates. The only cause which seems probable is unequal expansion and contraction of the plate setting up strains which ultimately developed into a crack. No doubt there was some flaw in the plate at the crack which would account for it starting in that particular plate. The only remedy for this was to fit a new tube plate, so the tubes were drawn.



MICRO-PHOTOGRAPH OF FRACTURED PORTION OF CONDENSER TUBE

It was observed that many of the tubes broke in the process of withdrawal, showing a brick-red fracture surrounded by a thin film of yellow brass. The appearance is shown in the accompanying micro-photograph. The thin white strip which formed the outer layer was approximately of the original composition of the tube, namely: 70 percent copper, 30 percent zinc, while the thicker and darker portion forming the inner layer was composed mostly of a spongy mass of almost pure copper. The magnification is 7½ diameters, and the photograph is unique in its way, being, so far as the writer is aware, the only one showing the outer and inner layers of brass and copper.

The explanation of the disappearance of the zinc from the alloy is not far to seek. Consider the parallel case of a galvanic battery, consisting of two simple elements immersed in an electrolyte and connected by a wire. We get a current of electricity from such a cell but at the same time one of the elements is destroyed. If this reasoning is applied to a condenser tube immersed in sea water it will be seen that the two cases are similar. The tube is a mixture of two elements, copper and zinc, and is immersed in an electrolyte consisting of sea water. The two metals with the sea water form a series of minute galvanic cells, which results in the destruction of the zinc.

The above case is typical of many, and as yet no remedy has been found which will prevent the removal of the zinc. The corrosion committee of the Institute of Metals have just brought forward their second report, presented by Mr. G. D. Bengough and Mr. R. M. Jones. As the result of their experiments these gentlemen suggest using an alloy of 70 percent copper, 29 percent zinc, 1 percent tin (Admiralty alloy), or 70 percent copper, 28 percent zinc, 2 percent lead (Muntz's special brass), instead of the usual standard 70 percent copper, 30 percent zinc alloy. Two other most important suggestions are that more use should be made of electrochemical means for retarding corrosion, and that the temperature conditions should be carefully looked after. Clyde.

Collision of the Colmar and Mavis

A collision between the *Colmar*, of the Deutsch-Australisch Dampfgesellschaft, and the *Mavis*, of the General Steam Navigation Company, took place in the new waterway near Rotterdam on the morning of Sept. 17. The *Colmar*, which is a cargo steamer of 6,000 tons, 460 feet long, was beginning a voyage from Rotterdam to Australia, and in proceeding through a thick fog ran into the port side of the *Mavis*, a new steamer running between London and Rotterdam. One passenger on the *Mavis* was killed by the collision and another was seriously injured. The *Mavis* sank within half an hour, and her crew was taken off by the *Colmar*, which steamed back to Rotterdam, where she was unloaded and docked for repairs.

THE SUNKEN MAVIS

The Batti Wallahs Society

Sea-going electrical engineers have their own peculiar troubles which have to be experienced in order to be realized, and it is therefore only the adjustment of the balance that on shore they manage to arrange for themselves an uncommonly good time. It is a striking testimony to the efficiency of the education which an electrical engineer on board ship receives, that many of the most important electrical engineering positions on shore are filled by men who have at one time or another in their career coaxed a balky bearing through the Red Sea, or traced the wandering ampere from the ship's dynamo to the hull where it ought not to be. Even when the perils of the sea are past, and the former sea-going electrical man has settled down to the enjoyment of emoluments and other pleasures of paradise on land, he does not forget the smell of the salt sea, and foregathers when occasion arises with the men who have been through the mill with himself.

In this way a most interesting society was instituted in 1906 in Great Britain which is known as the Batti Wallahs Society. It owes its backbone of membership to former electrical engineers of the Peninsula & Oriental Line who have now settled on shore, and who still retain a lively interest in marine electrical engineering, in each other, and to a limited and decorous extent in each other's wives and daughters. As a result of this the society has instituted during the winter a very festive concert season, each season including a couple of evenings in which the performers are only dimly seen through a haze of smoke, other evenings, which are labeled "informal," the title being quite correct, a dinner and annual general meeting. In addition to this the society publishes a quarterly journal, which is perhaps among the crispest literature extant, the talent of the Batti Wallahs evidently running very strongly in the direction of original sketches and still more original poetry. During the summer, among other festivities, a yachting cruise was arranged for the water Wallahs in a converted barge (this term is not used in a religious sense) known as the *Alde*.

Some idea of the incidental features of these summer trips may be obtained from an account for which we are indebted to Mr. H. J. Greenly, the honorary secretary of the entertainment committee of this society. The first summer function was a down-river trip from the Temple Pier in London to Canvey Island. Last year and this the society was singularly unfortunate in choosing their weather, and last year the motor boat used nearly foundered, and were it not for the fact that the Batti Wallahs on these trips are good navigators, something unfortunate might have happened. This year, on the same trip, they managed to knock a hole in the vessel by hitting some floating wreckage, but the accident was not discovered until the fly-wheel of the engine was throwing water up like a catherine wheel. The engine kept going until more than half submerged, and with the aid of the floor boards, which by that time were floating around those members of the society who were on board, the vessel was paddled sufficiently in-shore to feel bottom with a boathook before she sank. Except for a few heavy goods which had to be jettisoned, everything was salved, including the members and the boat.

Another annual event is the up-river trip to the beauty spots of the Thames, which is always a great success, about seventy ladies and gentlemen being on board during the present year's trip. Other similar trips are provided, but the chief feature is the cruise in the *Alde*, which is owned by the president of the society, Mr. Walter Riggs. The barge carries grain round the coast except during the time which it is being used as a pleasure yacht, and in order to fit it up for the purpose of the society some simple alterations are necessary. The well-known firm of British electrical engineers, Messrs. Siemens Bros., presented the society with the lamps, fittings and shades; another firm, Messrs. Pooley & Austin, provided them with a new 3½-kilowatt kerosene (paraffin) engine and generator, including switchboard and rheostat, while Messrs. Simplex Conduits provided the necessary cable and a Dutch oven type of electric cooker, together with a large grill, hotplate, toaster and two kettles. The batteries were used for lighting, and the cooking was done direct from the dynamo, half a pint of kerosene (paraffin) being sufficient to cook breakfast for sixteen.

The official Batti Wallah barge trip was from Friday before August Bank Holiday (the first Monday in August) to the following Monday week, a period of eleven days, inclusive. The start was made from North Woolwich on the Saturday, and Sheerness was reached on the first day, from there on to Harwich and Ipswich, and to Lowestoft, or Aldeburgh, returning to Brightlingsea and Burnham-on-Crouch, and occasionally to Margate and Ramsgate. The question of direction depends on wind and tide. On board a chart and log books are kept. On the chart is marked the course of each day's sailing, and a regulation log is kept of wind, tides, distance traveled and other information of interest to enthusiasts.

Altogether the Batti Wallahs manage to enjoy themselves very well, and the society has the purpose of knitting together in social intercourse men who would otherwise drift apart and forget the call of the sea. It would be a very useful thing if electrical engineers in the United States could follow some similar programme, as it would have the double value of providing social enjoyment and of providing a nucleus of concerted action in the many pressing problems which are attendant on the conditions of work of the sea-going electrical engineer. S.

"Hand Drilling"

In an article on "Hand Drilling" by Mr. A. L. Haas in the August issue, the writer notices the following statement: "The downward pressure needed for a 1-inch twist drill to be approximately 4 tons."

This statement appeared to the writer to be open to criticism, and the following are certain reasons which led the writer to believe that this figure is overestimated: It is possible, of course, that a pressure of four or even more tons might come on a 1-inch drill were the drill not in good condition; but given a drill properly sharpened it would appear that a 1-inch hole could be bored with considerably less pressure than that stated in the article.

The writer turned his attention first to the ordinary column drill, and considered whether it would be possible to raise, with the hand gear provided, a weight of 4 tons placed on top of the spindle. It did not seem reasonable to assume that, and yet a 1-inch hole can be bored by using the hand feed; in fact, if the automatic feed be shut off quickly, and the hand feed tried, it will be found that (provided the drill is in good condition) the drill may be fed in an appreciable distance beyond that which the automatic feed has given it.

Consider now the case of a portable electric boring machine, the type of machine that is now employed in many cases where a ratchet was formerly used. The writer recently had occasion to bore some 1-inch holes in wrought steel with an electric machine and a 1-inch Morse twist drill. The machine used had a ⅝-inch Whitworth screw fitted with a sleeve provided with a small cross handle for feeding in the drill. The drill was fed in by revolving the sleeve by hand, no great effort being required to make the drill take a good cut. Now the writer is sure everyone will admit that it is impossible to put a pressure of 4 tons on a ⅝-inch Whitworth thread screw.

Consider, now, the case of an ordinary ratchet brace, such as described by Mr. Haas in his article. The writer has found it possible to bore 1-inch holes, using an ordinary lip drill, by turning the box of the ratchet by hand, yet it is impossible to raise a weight of 4 tons by this means.

The above are the main reasons why the writer considers the pressure stated in the article overestimated. "Ison."

Glasgow.

Marine Articles in the Engineering Press

Shallow Draft River Boat St. George.—This boat was built by the Ailsa Shipbuilding Company, Ltd., of Troon, to the order of the Foreign Office for government service on the Congo. It is 110 feet long with a draft of 3 feet, and was built in three sections to facilitate transport to and erection in West Africa. An upper deck is fitted with four cabins and a dining saloon for accommodating passengers. Propulsion is by three sets of 76 brake horsepower British Kromhout oil engines, driving three propellers. The engines run on petroleum, a sufficient supply being carried for a trip of 3,000 miles. 9 illustrations. 450 words.—*Engineering*, October 31.

Typical Ships, No. III. A Steam Yacht.—Some idea of the many possibilities which are open to the architect in the design of a steam yacht, as well as the great variety of conditions which may be imposed by the owner, is pointed out to show the many features which will outline the size, type and characteristics of a steam yacht. As an illustration, a very thorough description is given of the *Sapphire*, designed by Messrs. G. L. Watson & Co., of Glasgow, and built by John Brown & Co., Ltd., of Clydebank, for the Duke of Bedford. The yacht is 251.4 feet long, 56.15 feet beam and 18.15 feet depth, with a Thames measurement of 142 tons. She is of conventional type propelled by a pair of four-crank triple expansion engines, the cylinders of which are 18, 29, 32 and 32 inches diameter, with a stroke of 27 inches. Steam is supplied at a pressure of 180 pounds by two three-furnace single-ended Scotch boilers and one smaller boiler for auxiliary purposes. Running at 169 revolutions per minute, the engines develop a combined horsepower of about 3,400, which gives the yacht a maximum speed of just over 15½ knots with forced draft. A cruising speed of 13 knots is obtained under natural draft. 11 illustrations. 4,000 words.—*The Engineer*, November 7.

The Twin Screw Passenger and Cargo Steamers Gablonz and Marienbad.—Destined for the Austrian-Lloyd mail, passenger and cargo service from Trieste to Bombay, these sister ships have been completed recently by the Cantiere San Rocco S. A., of Trieste. The dimensions are: Length between perpendiculars, 450 feet; breadth, molded, 56 feet; depth, molded to upper deck, 31 feet 5 inches; draft, fully loaded, 25 feet; gross tonnage, 8,450; speed, fully loaded, 16 knots; indicated horsepower, 7,500; capacity for cargo, 209,700 cubic feet; number of passengers, 150 first class, 30 second class, 100 third class. Each vessel has six decks, with the passenger accommodation all situated above the upper deck, the spaces beneath that deck being devoted to cargo and the machinery. Subdivision is by ten main transverse watertight bulkheads, extending to the upper deck, or to a height of 6½ feet above the maximum load line. Further subdivision is provided by a double bottom between the peak bulkheads. The article gives a detailed description of the passenger accommodations, illustrated by a number of excellent photographs. The electric plant consists of three turbo generators, capable of giving a continuous output of 200 kilowatts at 100 volts when the generators are running at 3,000 revolutions per minute. The cargo handling gear consists of four derricks at each hatchway attached to derrick posts and arranged to be used in pairs, one derrick being placed over the hatch and the other over the side, the lifted weight being transferred from one to the other by means of running tackle controlled by a double-barreled winch of Sieurin's latest type. One winch is supplied for each pair of derricks, the capacity of each derrick being 2½ tons. Propulsion is by twin screws driven by two sets of quadruple expansion engines with cylinders 26, 37, 53 and 76 inches in diameter, respectively, with a stroke of 51 inches. The machinery was built by Stabilimento Tecnico, of San Andrea, Trieste. Steam is supplied at 215 pounds pressure by eight single-ended cylindrical boilers, operating under Howden's system of forced draft. The total heating surface is 18,880 square feet, and the grate area 473 square feet. Details of the auxiliary machinery are enumerated, and the machinery arrangement is illustrated by line drawings. On a twenty-fours' trial the *Marienbad* maintained a speed of 16.2 knots with the engines running at 86 revolutions per minute and developing about 7,600 indicated horsepower. 20 illustrations. 2,500 words.—*The Shipbuilder*, November.

Electric Equipment and Concrete Construction at Auckland Harbor.—The harbor at Auckland carries so large an amount of shipping that the available wharves must be kept permanently ready for service. Destructive elements, such as tides, wind and marine life, compelled the replacement of short-lived wooden wharves by durable long-lived ferro-concrete structures. Horse and cart congestion, the handling and rehandling of cargoes in the narrow ill-lighted sheds, compelled the introduction of overhead and portable electric cranes, electric capstans and motors and efficient clusters of high power electric lamps. In the earlier wharves, a single line of sheds ran down the center of the wharf and the ships discharged into these from either side, while carts were permitted to enter the sheds for the purpose of loading or unloading. All moving of cargo within them was done by hand, in spite of the fact that the height was well over 8 feet, which is usually regarded as the official limit for manual tiering. These conditions resulted in congestion and delays, so that a new scheme was adopted in the general arrangement of the new wharves. A double row of sheds either one or two stories high, separated by a 60-foot roadway, extends the length of the wharves, the sheds themselves are 60 feet wide and have a 30-foot quay running along their outer sides. On this quay are mounted portable revolving cranes which transfer freight direct from the hold of the ship to railway cars on the quay or to the pier sheds. No cranes with a lifting capacity greater than 5 tons have been installed, as heavier weights are handled by an 80-ton floating crane. Most of the cranes are semi-portal supported; that is, on one leg only upon the coping of the wharf, the other being carried on a crane rail on the eaves of the shed. The cranes are operated by electricity furnished from the municipal power station. Small cranes are used mainly for tiering inside the sheds, and are moved from place to place by hand. The large cranes are moved by electric capstans placed at convenient distances on the quays. For double-story sheds conveyors and lifts, electrically operated, are installed. 22 illustrations. 4,000 words.—*The Engineering Magazine*, November.

U. S. S. Cassin and Cummings.—By Henderson B. Gregory. The *Cassin* and *Cummings*, built by the Bath Iron Works, at Bath, Me., are two of the eight torpedo boat destroyers authorized in 1911. They are twin screw vessels, fitted with a combination of Parsons turbines and reciprocating engine and designed for a speed of 29 knots at a trial displacement of 1,010 tons, with the main turbines alone developing 16,000 shaft horsepower. The dimensions are: Length on load waterline, 300 feet; length overall, 305 feet 3 inches; beam, extreme on load waterline, 30 feet 3 inches; draft, 9 feet 3 inches; corresponding displacement, 1,010 tons. The armament consists of five 4-inch rapid fire guns and four 5.2 meter by 45 centimeter twin torpedo tubes, mounted on the main deck. Of the propelling machinery, the turbines are designed to run at 550 revolutions per minute when developing 16,000 shaft horsepower, and the cruising engine is designed to develop 700 indicated horsepower at 270 revolutions per minute. The engines are arranged on two lines of shafting. On the starboard shaft is the main high-pressure ahead turbine, and a separate astern turbine. On the port shaft is the low-pressure ahead turbine, in which is incorporated the low-pressure astern turbine. Forward of the low-pressure turbine and fitted to the port shaft by a clutch is the compound cruising engine with cylinders 16 inches and 24 inches diameter and 18 inches stroke. The propellers are three-bladed, 7 feet 4 inches diameter and 6 feet 8 inches pitch, with a projected area of 25.375 square feet, a helicoidal area of 28.69 square feet and a disk area of 42.24 square feet.

Steam is supplied by four oil-burning Normand watertube boilers, arranged in pairs in two separate compartments. At full power they operate under an air pressure in the firerooms of about 5 inches of water. The working pressure is 260 pounds and the heating surface of each boiler 5,377 square feet. There are twelve oil burners of the Modified Bureau of Steam Engineering type, and the fuel oil system consists of two light service booster pumps, four heavy pressure service pumps; two oil heaters and the oil storage tanks in the forward and after holds, together with the necessary piping and fittings. The *Cassin's* trials were run June 24 to 28, 1913, on the Rockland (Me.) course. Twenty-six runs were made on the standardization trial at various speeds over the measured mile, giving the mean revolutions per minute of the propellers for speeds of 12, 15½, 24 and 29 knots, respectively, as 197.3, 259.2, 421.1 and 565. On a four-hour full-power trial a speed of 30.137 knots was obtained on a displacement of 1,011 tons, the engines developing 15,307 shaft horsepower. 4 illustrations. 8,800 words.—*Journal of the American Society of Naval Engineers,* August.

The Underwater Horizontal Hydraulic Ash Discharger on the U. S. Colliers Proteus and Nereus.—By F. P. Palen. Experience with apparatus for expelling ashes straight down through the bottom of a vessel has shown that ashes expelled in this way will find their way into the pump suctions located aft of the openings through which the ashes are expelled and cause serious wear in the pump cylinders, and also block up the ends of the condenser tubes. In order to overcome these serious objections, there has been developed at the works of the Newport News Shipbuilding & Dry Dock Company and installed on the U. S. colliers *Proteus* and *Nereus* a hydraulic ash discharger of the horizontal type for discharging the ashes through the side of the vessel below the waterline in locations where the ashes will drift clear of the pump suctions. The apparatus consists of a horizontal hydraulic jet which forces back the sea water and carries overboard the ashes which are introduced through a hopper at right angles to the hydraulic jet. The hydraulic jet is produced by an annular nozzle, so formed as to cause the conical shaped water jet to converge and form a solid stream beyond the end of the annular nozzle and then diverge into an ordinary hydraulic stream. The solid portion of the jet, where it passes through the contracted portion of the pipe beyond the discharger, forces back the sea water and creates a suction in the ash pipe forming the inside ring of the annular opening through which the discharge water passes. This suction drives whatever is contained in the ash pipe into the hydraulic system and carries it overboard. In actual operation on the *Proteus* the jet created a suction equal to 18 inches of vacuum when the cover of the ash hopper was closed. The water for the hydraulic jet is supplied at a comparatively low-pressure from a turbine-driven centrifugal pump. The jet operates when the water pressure at the jet is equal to or slightly greater than the head of water equivalent to the draft of the vessel. The jet works effectively with a pressure of less than 25 pounds gage. Other special features for the apparatus are a rotating ash valve which is operated by a small double cylinder engine that will start from any position. This valve is made with a hardened cast steel rotor and acts as a crusher, preventing pieces from passing that are too large to go around the bend in the ash pipe. The valve also serves to prevent any large inrush of water into the vessel in case the sea valves and hopper covers are left open when the pump is not running. A small jet of water is introduced into the bend in the ash pipe to assist the suction to carry the ashes clear of the horizontal portion of the ash pipe nozzle. There is no wear on the discharge pipe, as the ashes are carried out in the stream and at a speed sufficient to shoot them clear of the side of the vessel. The rated capacity of the discharge is from 12 to 15 tons per hour. 7 illustrations. 2,000 words.—*Journal of the American Society of Naval Engineers,* August.

The Polar Diesel Engine.—This is a continuation of a series of articles which the editors have presented on the Diesel engine, taking up the various types of engines built in Great Britain, Germany, Italy, Belgium, Holland, Switzerland, Denmark, France, the United States, Sweden and Russia. All of these have been described previously except the engines built in Sweden and Russia. The present article is devoted to the various types of Diesel engines built by the Aktiebolaget Diesels Motorer, Stockholm, Sweden. This firm claims to have constructed the first reversible Diesel engine and has now been regularly constructing this type of engine for marine purposes since 1907. Twenty-seven sets have already been actually fitted on board ship, varying from 60 to 260 horsepower, while not less than twenty-nine sets are under construction, the maximum power having advanced to 1,650 in six cylinders. A radical departure in the Polar Diesel engine is in the arrangements for starting and maneuvering. In this engine the scavenge pistons are temporarily diverted from their duty and converted into an independent two cylinder double-acting starting engine. The article is the result of personal observation and investigation, and presents in detail the various features of the engine and its operation. 11 illustrations. 5,500 words.—*The Engineer,* October 24.

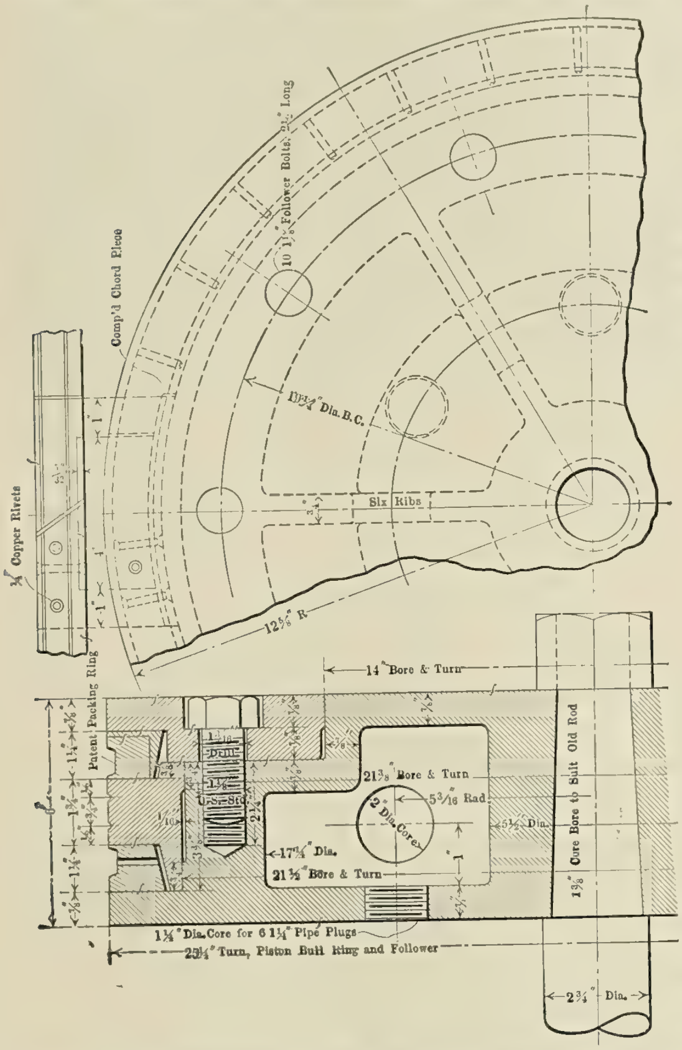
U. S. Fleet Collier Jason.—By Henderson B. Gregory. The U. S. collier *Jason,* authorized in 1911 and built by the Maryland Steel Company, of Sparrows Point, Md., has a speed of 14 knots at about 19,130 tons displacement, with the main engines developing about 6,800 indicated horsepower. The dimensions are: Length overall, 536 feet; length on waterline, 514 feet; beam on load waterline, 65 feet 2½ inches; draft, 27 feet 4½ inches; corresponding displacement, 19,130 tons. Propulsion is by two triple expansion engines with cylinders 27, 46 and 76 inches diameter and 48 inches stroke, designed to develop 6,800 indicated horsepower at 90 revolutions per minute. Steam is supplied at 200 pounds pressure by three double-ended Scotch boilers, 16 feet 1 9/16 inches diameter and 21 feet 4⅝ inches long, with 6,307 square feet of heating surface and 146.7 square feet of grate surface. The standardization trials were run over the Delaware Breakwater measured mile on June 18, showing that it required 93.1 revolutions per minute of the main engines to give the contract speed of 14 knots. On the twenty-four hour full-power trial, with a mean draft of 27 feet ½ inch and a corresponding displacement of 18,862 tons, the engines developed 6,878 indicated horsepower at an average of 95.2 revolutions per minute, giving a mean speed of 14.322 knots. Tests of the coaling gear showed that 128 tons of coal could be discharged per hatch per hour. The fore-and-aft coal transfer gear was also tested, showing that coal could be transferred from the after hatch to the forward hatch at the rate of 72 tons per hour. 1 illustration. 2,000 words.—*Journal of the American Society of Naval Engineers,* August.

U. S. Destroyer Henley.—On her final speed trials off Sandy Hook, N. J., Nov. 17, the United States torpedoboat destroyer *Henley,* built by the Fore River Shipbuilding Company, Quincy, Mass., attained a speed of 30.3 knots, or an increase of .8 knot beyond contract requirements.

ENGINEERING SPECIALTIES

The R. C. Monteagle Packing for Pistons and Piston Valves

The purpose of the R. C. Monteagle packing, which is manufactured by the Lockwood Manufacturing Company, East Boston, Mass., is to prevent leakage around pistons and piston valves where steam, water, air, ammonia or gas is used, and to do this with practically no friction. The packing is usually made with two floating packing rings and a bull ring to center and guide the piston. The construction, as applied to a piston,

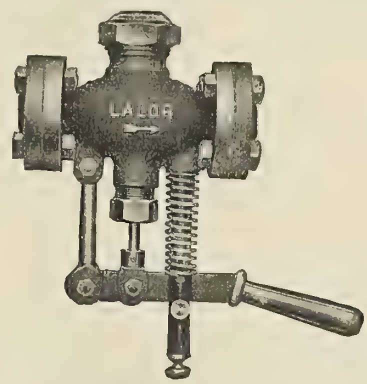


is shown in the illustration. The ring, it is claimed, is tight for an indefinite period of time; does not "slap"; runs practically without friction and therefore with a minimum of wear. These highly desirable results are obtained by cutting the rings angularly at the back, as shown in the illustration. It is well known that steam finds its way back of the ring, and as there is an almost constant pressure in this space the rings are not only held out against the walls of the cylinder but against the follower and piston flange as well, cutting the leakage down to a minimum. Any steam which may pass the first ring is stopped by the second. Carefully fitted "chord pieces," or joint breakers, are fitted to each ring. The principal claims made for these packing rings are that they are tight under the most severe conditions of service; they operate with minimum friction, as they are practically balanced; they cause little wear to cylinders or pistons; they are suitable for either high or low-pressures, ranging from vacuum to 1,000 pounds; they adjust themselves automatically to the variable pressures encountered in all cylinders; they are suitable for steam, air, water or ammonia, and they give a high efficiency, and hence greater economy in fuel.

This packing can also be applied equally well to piston valves. A case in point is that of an automatic high-speed engine with high-pressure and low-pressure piston valves on the same stem, the whole being operated by a shaft governor. The builders of this engine had been accustomed to omit rings in the valves, as they had been unable to design a tight valve with packing rings which would operate freely. The type of valve used was the "plug" valve, and when this was fitted with the new patent packing rings just described, it was found to operate not only as freely as before but an increase of power of over 30 percent was gained by the installation. There were eight rings in the combination valve, and it was found that the governor controlled the valves as sensitively as before the rings were applied, showing that friction was reduced.

Lalor Automatic Stop Valve

The Lalor automatic stop valve, manufactured by the Lalor Fuel Oil System Company, Philadelphia, Pa., was designed to prevent fire and loss of life in connection with the use of any burning liquids. It minimizes the danger which has hitherto attended the use of fuel oil by providing the equipment with positive valve control. The valve can be used in connection with various oil-burning systems, such as steam boilers, heating and tempering furnaces, rivet forges, portable torches and



gas retorts. The valve has been placed on the approved list of the Underwriters' Laboratories and has also been approved by the United States navy.

This automatic stop valve has a distinct feature, in that all the working parts are submerged, and they are therefore not subject to the action of the air, and, consequently, corrosion is prevented. Furthermore, the general design of the valve is such that the controlling forces acting on the plunger are greatly in excess of any friction that might possibly occur, so that the valve cannot fail to operate. The reliability of the valve and absence of failure are shown by a series of tests made on a number of these valves, where out of forty-six hundred fractures of various sizes the valves never had a single failure.

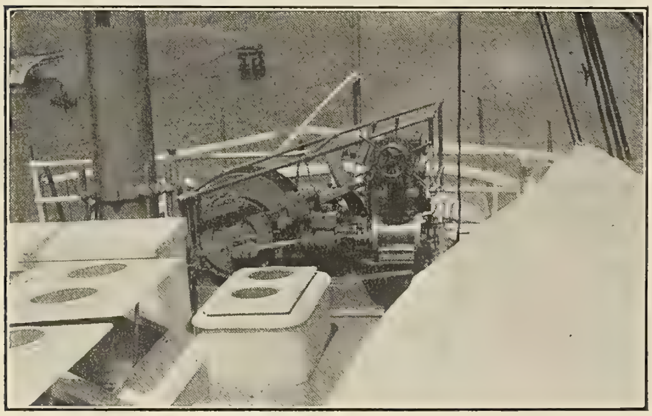
The complete Lalor system for safeguarding the use of fuel oil is composed of a master valve situated at the tanks or pressure means, group control valves for the pipe system and individual control valves which control the burner operation on each furnace. A test of a ½-inch individual control valve, made on a bolt-heating furnace, prevented the operator of that furnace from drawing more oil than the furnace could properly consume, and when the operator attempted to throw open the ½-inch needle valve, the flow of oil was checked with a loss of only 2 ounces, and the fire was thrown not more than 12 inches beyond the furnace doors. A similar test, made on the same furnace but without the use of the automatic stop valve, showed that the fire was thrown for a radius of 35 feet.

The approval of the United States navy for this valve was obtained when one of the destroyers was equipped with a full system, which was given a thorough service test. Since then installations have been made on the battleships *New York*, *Texas* and *Nevada*. In the merchant service, one of the recent vessels of the American-Hawaiian Steamship Company has also been equipped with this device.

Life=Saving Appliance

In view of the difficulties encountered in rescuing passengers from the ill-fated *Volturno* during a gale, attention is called to an apparatus which was installed several years ago on the United States revenue cutters *Acushnet* and *Snohomish*, and which has been used successfully in rescue work under trying conditions. On these vessels a Hall breech-loading line-throwing gun is provided, mounted upon a peculiar type of carriage that can be secured to the rail of the vessel at any point, and which can be accurately trained and fired without recoil trouble in a seaway, throwing a line with accuracy up to a distance of 2,000 feet. As soon as communication is established by throwing a line across the distressed vessel, tackle can be hauled on board and made fast to the mast by means of which a wire cable and breeches buoy can be passed to the wreck. The breeches buoy equipment installed on the revenue cutters mentioned is of the Spencer Miller type, in which the cable for the breeches buoy passes through a block on the mast head of the rescue ship to an automatic reel on the deck, operated by an automatic tension engine which constantly pays out and takes up on the main cable to compenstate for the motion of the ships. In this apparatus a hauldown block is provided so that the passengers in the breeches buoy can be landed directly on the deck of the rescue ship. An apparatus by which communication can be established between two ships at a safe distance apart in a rough seaway, and by which human beings can be transferred rapidly from one ship to the other in spite of the violent tossing of the vessels and the constantly varying distance between them, should be carefully considered by shipowners and government authorities as a possibility in life-saving equipment.

SPENCER MILLER BREECHES BUOY IN ACTION



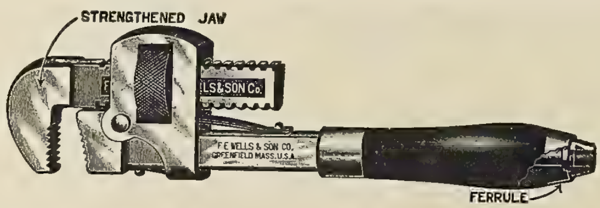
AUTOMATIC TENSION ENGINE

Testing of Lubricants

Rough-and-ready methods of testing lubricating oils to ascertain their suitability for various purposes are frequently misleading, and lacking a standard of comparison are of little practical value to the engineer. The Stern Sonneborn Oil Company, Ltd., London, E. C., has produced a comparatively simple and reliable apparatus, known as the Sternol oil testing machine, to be used for determining the value of lubricating materials under actual working conditions, with means of standardizing the results obtained. This machine, it is claimed, is capable of reproducing the exact working conditions of any machinery, steam, gas and oil engines, covering such items as load, speed, cylinder pressure, temperature, etc. By means of this apparatus the engineer is able to determine with certainty the suitability of an oil or grease for any given purpose and also to prepare charts showing the comparative efficiency of various qualities.

"Wells" Pipe Wrenches

F. E. Wells & Son Company, Greenfield, Mass., has on the market pipe wrenches with especially strengthened jaws and



fitted with double ferrules to protect the wood handles from breaking. The construction of the wrench is shown in the illustration.

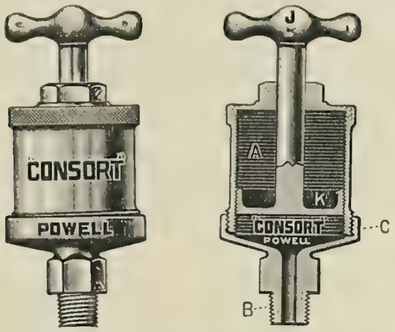
"Thread=Tight"

"Thread-Tight," manufactured by the Thread-Tight Company, New York, is a compound for making tight either screwed or flanged joints on high-pressure steam, ammonia or pneumatic lines, high-service hydraulic work, acid lines, gas piping or boiler caps, manholes, etc. It is claimed by the manufacturers that neither heat nor cold will affect the compound, and that it can be put on a wet surface, such as an iron pipe submerged in water, adhering to the wet surface as firmly as to a dry pipe. "Thread-Tight" does not become hardened in the joints, and therefore does not injure the thread when breaking the joints. It is used as a preservative for gaskets, preventing their deterioration, and the gaskets are readily removed should occasion arise.

Another compound known as "Gasoltite" is furnished by the same company. This compound is said to be gasolene (petrol) proof and of great value on account of its not hardening qualities in motor boat, automobile and engine service for threaded and flanged connections which have to stand gasolene (petrol). It is a lubricant for gasolene (petrol) plugs, valves, cocks, plungers, etc.

The Powell "Consort" Screw Feed Grease Cup with Screw Plunger Feed

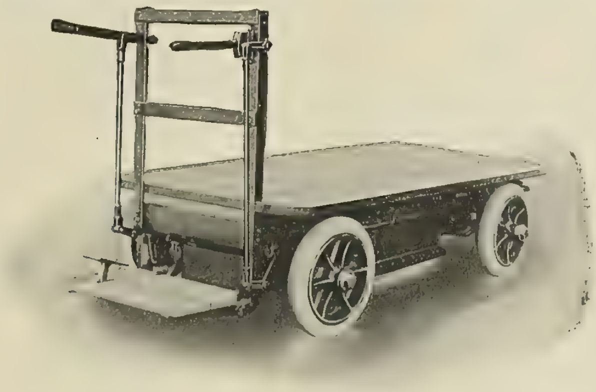
The Powell "Consort" screw plunger feed cup is manufactured by The William Powell Company, Cincinnati, Ohio, to meet the demand for a simple, cast brass highly finished grease cup. The most important feature of this cup and its advantage is that of being easily refilled, as the bonnet which carries the grease can be removed from the base for this purpose, the base



remaining in position. The cups are adapted for marine engines, air compressors and ice machines, and wherever it is necessary to force the grease some distance, being suitable for an intermittent or positive feed. The operation is simple. The threads in the bonnet and plunger are a close and snug fit, work freely, and with ordinary care will not permit the grease to crowd past. By screwing down the plunger the grease is forced to the bearing.

The Hunt Storage Battery Industrial Truck

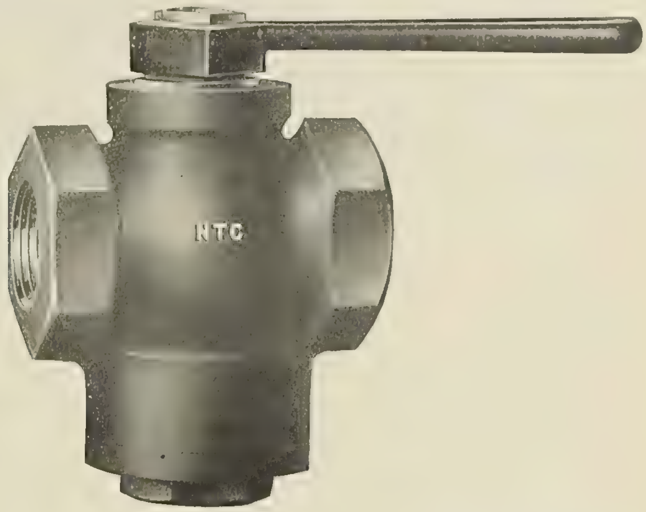
The Hunt storage battery industrial truck, built by the C. W. Hunt Company, Inc., of New York, is designed for conveying heavy material around manufacturing plants, shops and railroad terminals, etc., where it can be run with the utmost flexibility, put on elevators and conveyed to different floors, or run directly into box cars, all of which would be practically impossible with a system of tracks. These trucks are very compact and have a capacity of approximately 4,000 pounds.



With this load the maximum speed is about 5 miles per hour. The storage capacity of the batteries is ample for an ordinary full day's working. Either Edison iron and nickel cells or Exide lead cells are supplied. The storage battery cells are encased in a battery box of heavy steel, suspended by springs from the cross members of the frame. The entire section of the top of the truck over the battery box is removable, thus making the batteries readily accessible. The motor is especially designed for vehicle service, with storage batteries, and drives the wheels through a differential of cut steel gearing, all enclosed in an oil and dust-proof housing. Ball and roller bearings are used throughout. The operator's platform is at the front of the truck, as shown, from which the truck is steered by the right-hand lever. The other lever controls the motor, and the brake is actuated by the foot pedal. When not in operation the truck is always locked.

National Spring Plug Cock

The National spring plug cock, manufactured by the National Tube Company, Pittsburg, Pa., was designed to overcome the disadvantages of the ordinary style or through-plug cock. When the plug becomes loose in the ordinary type of



cock, the workmen frequently injure the plug in tightening it. Also, if the plug becomes cemented to the body, it is common practice to loosen the nut and drive up the plug with whatever tools are at hand, no special care being taken to properly adjust the plug afterwards. The National spring plug cock on the other hand has an inverted plug with a spring at the bottom, which constantly presses the plug firmly against the seat. While the plug usually turns easily, if for any reason it should stick it may be loosened by a blow on the top, after which it is immediately reseated by the spring. The cap at the bottom is screwed secure into the body and cannot be tampered with by the workman. These cocks are tested to 250 pounds cold-water pressure and to 125 pounds compressed air pressure under water, and are recommended for 125 pounds working pressure.

SWEDISH DIESEL ENGINES TO BE MANUFACTURED IN AMERICA.—A new corporation, known as the McIntosh & Seymour Corporation, has just been formed with a New York State charter to engage in the manufacture, on an extensive scale, of a full line of Diesel engines, both stationary and marine. The company, which is backed by American interests and also to a large extent by Swedish capitalists who now control the Swedish Diesel Motor Company (Aktiebolaget Diesels Motorer), has taken over the plant and organization of the McIntosh & Seymour Company of Auburn, N. Y., builders of high-grade steam engines. The present steam engine business will be continued as heretofore, with the addition of the construction of Diesel engines, built on the Hesselman system.

LAUNCH OF THE FIONIA.—The motor ship *Fionia*, under construction by Burmeister & Wain, Copenhagen, for the East Asiatic Company, was launched Oct. 11. The vessel is 414 feet long over all; 395 feet long between perpendiculars; 53 feet breadth; 30 feet depth from awning deck; 24 feet 3 inches draft, with a dead weight capacity of 6,700 tons. The propelling machinery, consisting of two 6-cylinder Diesel engines, with a total of 4,000 indicated horsepower, will give the ship a speed of 13½ knots.

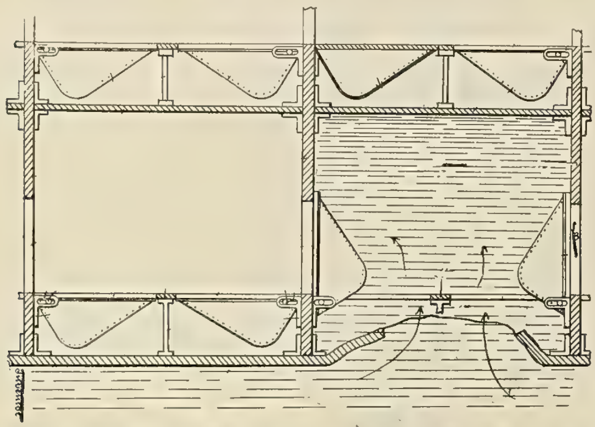
SELECTED MARINE PATENTS

The publication in this column of a patent specification does not necessarily imply editorial commendation.

American patents compiled by Delbert H. Decker, Esq., registered patent attorney, Loan & Trust Building, Washington, D. C.

1,071,845. SELF-CLOSING COMPARTMENT DOORS. WILLIAM P. WILBER OF PROVIDENCE, R. I.

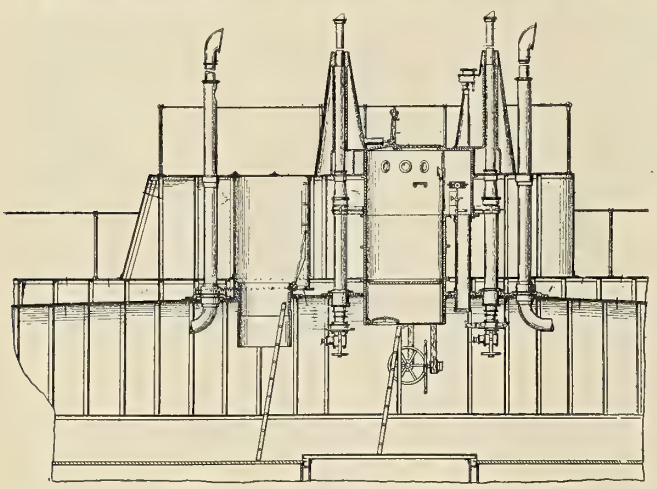
Claim 1.—The combination with a ship divided into a number of communication compartments, of self-closing doors for the same, said doors being hinged to the side walls of the compartments and forming, when in



their open position, bottoms for the same, and air tanks carried by said doors, whereby an inflow of water will move the doors to a vertical position, at which time the compartment will be cut off from communication with the adjoining compartments. Two claims.

1,072,393. SUBMERSIBLE-BOAT CONSTRUCTION. LAWRENCE Y. SPEAR AND HUGO E. GRIESHABER OF NEW LONDON, CONN.

Claim 1.—In a submersible vessel, the combination with a watertight hull constructed to withstand the pressure of deep submergence, and an upstanding observation tower also constructed to withstand such pres-



sure, of upstanding periscope tubes and ventilators outside of said tower, and a self-bailing and self-filling housing shaped to constitute a fairwater about said tower, periscopes and ventilators. Ten claims.

1,072,392. CONSTRUCTION AND CONNING EQUIPMENT FOR SUBMERSIBLE BOATS. LAWRENCE Y. SPEAR AND HUGO E. GRIESHABER OF NEW LONDON, CONN.

Claim 2.—In a submersible vessel, a conning tower having a periscope at one end thereof, an additional periscope extending down within the hull of the vessel at the same end of the conning tower, and a fairwater on top of the conning tower about the two periscopes. Four claims.

British patents compiled by G. E. Redfern & Company, chartered patent agents and engineers, 15 South street, Finsbury, E. C., and 21 Southampton Building, W. C., London.

9573/1913. AN IMPROVED METHOD OF OR MEANS FOR STABILISING SHIPS. W. J. DICKINSON OF URMSTON, NEAR MANCHESTER.

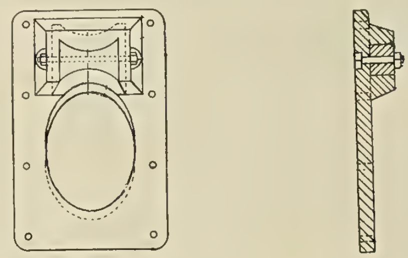
Claim.—For stabilising ships by means of a power-driven blower in communication with the various compartments of the ship by valve-controlled pipes through which pressure air can be led to drive out or prevent further influx of water resulting from a fracture of the hull of the vessel below the water line, the present invention consists essentially in the provision of turbo or other high-pressure blowers with or without a generator directly attached, and conduits leading from the blowers to the number of compartments required by automatic valve arrangements.

16,717/1912. IMPROVED APPARATUS FOR CLEANING THE HULLS OF SHIPS. F. G. BROWNE OF MALVERN, NEAR MELBOURNE, VICTORIA, AUSTRALIA.

Claim.—This invention relates to an improved apparatus for cleaning the hulls of ships or any kind of vessel, in which a cleaning device is suspended from a derrick mounted on a floating (or non-floating) punt or support separate from the ship to be cleaned and the degree of pressure of the actual cleaning member or members against the ship's hull is adapted to be regulated either entirely by the cables, chains or the like, by which the cleaning device is suspended, being adjusted relatively to one another, or partly by the relative adjustment of the cables, chains or the like and partly by means adjustably mounted on the cleaning device.

25,393/1912. AN IMPROVED SHIP'S HAWSE PIPE COVERING PLATE. W. F. P. SMITH AND D. T. REES OF BARRY DOCK, GLAMORGAN.

Claim.—This improvement in ship's hawse pipe covering plates consists in the provision of a renewable wearing surface in the form of a



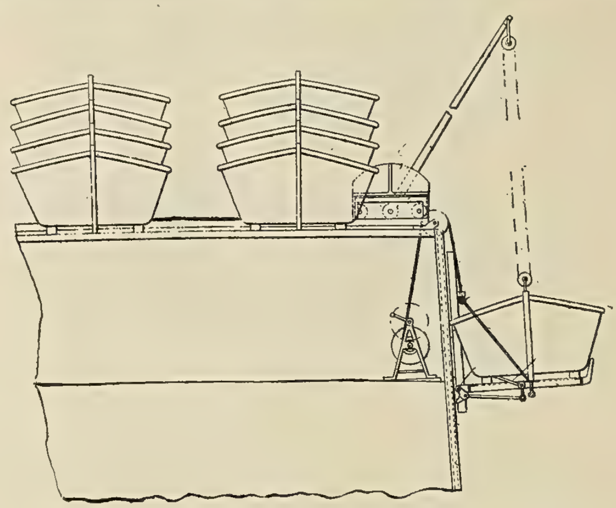
renewable block adapted to be fixed in a three-walled recess formed on the plate by a transverse pin or by a pair of bolts.

8,740/1913. AN IMPROVED ANCHOR. W. WENIGER OF PITSMOOR, SHEFFIELD.

Claim.—To obviate the use of loose trunnion pins, blocks, securing pins, etc., which take the back kick of the shank of an anchor, the head and fluked arms are formed of a single casting, the head being cored out to receive the shank and its integral trunnion, which turns on shoulders in the head, while the crown of the head is struck with such a radius from the center of the trunnion as will allow the crown to swing clear of the band (on the shank), which takes up the back kick of the shank, it being either shrunk, bolted or otherwise secured to shank just clear of the swinging head.

18,662/1912. IMPROVEMENTS IN MEANS FOR LAUNCHING SHIPS' BOATS. G. SCHULTZ OF BUSH LANE, LONDON.

Claim.—Relates to the launching of ships' boats, the invention being applicable for enabling passengers to enter or leave ships, for loading and unloading same, etc. Davits traveling on carriages, on rails on the



deck, are provided for bringing the boats to the side of the vessel and lowering them on to a grid which is pivoted to a carriage capable of sliding in grooves on the ship's side and upon which the boats are lowered, suitable tackle being provided for this.

17,984/1912. IMPROVEMENTS IN LIFEBOATS OR RAFTS IN COMBINATION WITH THE METHOD OF LAUNCHING THE SAME. J. MACNAB OF ISLINGTON, LONDON.

Claim.—This invention relates to an improvement in apparatus for launching boats from ships' decks in which a slip-way down which the boat slides engages at its rear end in guides upon the ship's deck and is adapted to be projected until its whole length extends over the ship's side, when the front end is lowered, hauling gear being provided for maintaining the slip in the plane of the guides until fully projected and then lowering its front end. A pinion engages a rack upon the slip for projecting it outwards or for returning it to its position upon the deck.

INTERNATIONAL MARINE ENGINEERING

Main Office: NEW YORK, 17 Battery Place   SUBSCRIPTION PRICE: Domestic, $2.00; Foreign, $2.50   LONDON OFFICE: 31 Christopher St., E. C.

International Marine Engineering

JANUARY, 1913

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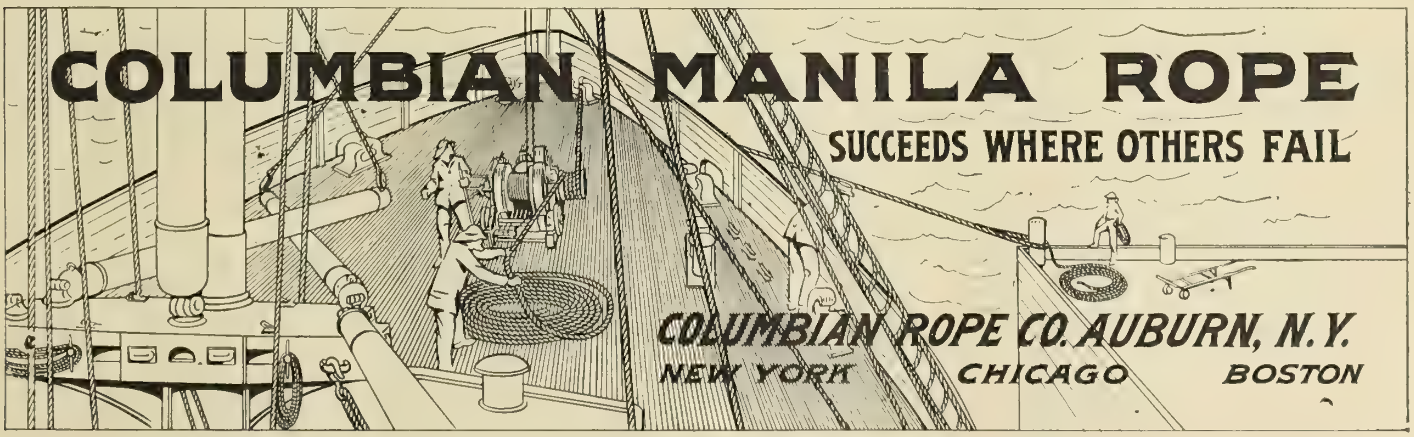

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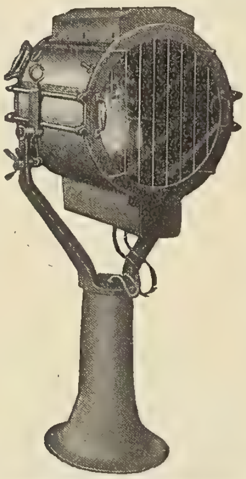

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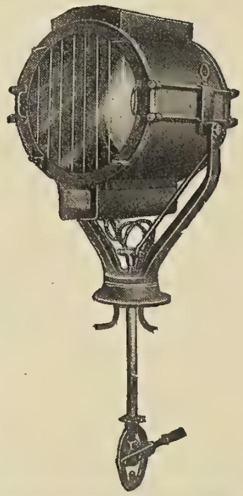
This Company is prepared to furnish from stock, standard commercial projectors of the 9, 13, or 18 inch diameter, for either pilot-house or hand control.



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Mexican General Electric Co., City of Mexico
Australian General Electric Co., Sydney and Melbourne
South African General Electric Co., Johannesburg, Transvaal, South Africa
Messrs. Guinle & Co., Rio de Janerio, Brazil
General Electric Co. (Special Representative) 137 Avenida Central, Rio de Janerio, Brazil
Messrs. W. R. Grace & Co., Lima, Peru and Valparaiso, Chile

General Electric Co. of New York, 83 Cannon St., London, E. C., England

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TRADE PUBLICATIONS.

AMERICA

Eckliff automatic circulators for marine boilers are described in a circular published by the Eckliff Automatic Boiler Circulator Company, Detroit, Mich. "The Eckliff automatic boiler circulator for Scotch boilers is a thermo-syphon, being governed entirely by the law of gravitation, and not depending on valves, injectors, pumps, hydrokineter attachments, or any other mechanical movement that is liable to disorder. It is made of special steel tubing, placed and shackled within the boiler on the furnaces, as shown by subsequent illustrations. The Eckliff circulator can be installed in any boiler, old or new, same having ordinary manholes, and complete installation can be made without cutting, mutilating or disturbing the boiler within two to three hours after boiler is cold. Our circulator once installed requires no further attention, because it is automatic, with no intricate mechanism to become abortive. It does not interfere in any way with entering and cleaning the boiler, and is not dependent upon the human element. The Eckliff circulator causes rapid and constant circulation of water in the boiler, thereby eliminating pitting, furrowing or cracking of furnaces and other destructive elements in the lower half of the shell. Hence vanish extensive repairs, expense and delay. Our circulator will not wear out, therefore no replacement or renewal expense has to be considered. The Eckliff circulator increases the life of the boiler fully 50 percent to 100 percent. By removing dead water in the lower half of the shell of the Scotch boiler, the unequal expansion, contraction and terrific strains under which a boiler is constantly laboring are eliminated, and leaky boilers at the bottom become ancient history. In other words, all disadvantages peculiar to the Scotch type of boiler are overcome. After installing an Eckliff circulator the temperature at the bottom of the boiler will be within a few degrees of the temperature of the steam chamber, according to pressure carried, causing the following benefits: Factor of safety; equality of heat top and bottom; perfect circulation; steaming capacity increased; clean, healthy boiler; scale formation minimized."

Thermometers for every purpose, and especially for use on board ship, are described in a catalogue issued by the H. & M. Division of the Taylor Instrument Companies, Rochester, N. Y.

"Dont's for Buyers of Lubricants" is the title of a folder issued by the Albany Lubricating Company, 708 Washington street, New York. Here are two of the "Dont's": "Don't purchase a lubricant because someone tells you a wonderful tale as to what it did for Tom, Dick or Harry. Find out exactly what it will do for you by testing it. You will be absolutely sure then. Order by test and you will order Albany Grease. Don't purchase ordinary greases that contain acids, resin, resinous oils, lime soaps, talc, etc., and which do not remain permanently neutral, free from acidity. Such greases contain the acids and foreign substances that eat the bearings, gum up, clog and create friction instead of reducing it. Have you ever wondered what the ill-smelling, discolored, hardened mass was that is left in the grease cup after using some ordiary grease? That residue composes the biggest part of ordinary greases."

"Plymouth Products" is the title of a monthly pamphlet published by the Plymouth Cordage Company, North Plymouth, Mass., and all interested in the subject of manufacture and use of rope should ask to be put on the free mailing list of this publication. "Those who have read the preceding numbers of this publication will recall that we narrated, briefly, the story of rope-making from earliest times down to the period when modern machine methods of manufacture were introduced. We also described the various fibers from which rope is made, and pointed out the importance of expert knowledge and foresight in the buying of these raw materials. Purchasing power and the resources for grading and using each bale of fiber, with strict regard to its particular fitness for his products, are also of special value to the rope manufacturer. Some account of the Plymouth Cordage Company's position in these matters should, therefore, be of interest to our readers prior to our description of modern rope-making processes. Rope is made for a great variety of uses and different fibers are employed, but Manilla fiber or hemp, as it is commonly called, is the principal, and for most purposes, the best material."

Terry turbines for marine work are described in Bulletin No. 16, published by the Terry Steam Turbine Company, 90 West street, New York. On the United States warships which were reviewed in New York harbor in October, and on the miscellaneous ships which stood near by, there were considerably over 100 Terry turbines. These are used for driving forced draft fans, for electric light generators, boiler feed pumps and ballast pumps. "The complete success of the Terry turbine on shipboard has been due to absolute reliability, because of simplicity of construction, unusually small space occupied, freedom from repairs, comparatively light weight and lack of vibration."

Cramp's gear bronzes are described in a booklet just issued by the William Cramp & Sons Ship & Engine Building Company, Philadelphia, Pa. "For many years we have been using bronze worm wheels and worms in the manufacture of hoisting engines, water turbines, turret-turning gear, steering gear and machinery of all kinds. We have also furnished these bronze wheels and worms for machinery constructed by our customers, such as elevators, lifting bridges, draw-bridges, locomotive drop tables, marine railways, automobiles, etc. Our experience has been so varied and has extended over such a length of time that we feel qualified to advise prospective customers in regard to the metals to be used for different purposes in gearing, and especially to advise engineers of the most suitable metals to use in new branches of machinery construction when it is desired to substitute gearing for some other means of power transmission. Our experience has led us to adopt for different purposes six different gear metals."

Marine refrigeration and ice making is the subject of a catalogue published by the Brunswick Refrigerating Company, 130 Jersey street, New Brunswick, N. J. A steamship, yacht, dredge or sea-going vessel of any type, unless equipped with a refrigerating plant, must either store a great quantity of ice or go into port at frequent intervals, both for ice and a fresh supply of meats and other perishable products. The installation of a special marine "Brunswick" makes a vessel independent of port so far as the commissary department is concerned. The steward may lay in his stores for weeks ahead and always serve fresh meats, dairy products and fruits. If ice is necessary in addition to the refrigeration provided, an ice-making set may be installed to manufacture any quantity required. Ice-making tanks are so constructed that the ship's motion cannot spill either the water in the ice cans or the brine in the tank. A small water cooler or shuttle-butt is a most convenient addition to the system. Among the many steamship companies whose ships are equipped with "Brunswick" refrigerating plants are the following: The American-Hawaiian Steamship Company, 22 vessels; A. H. Bull & Company, 5 vessels; Hamburg-American Steamship Company, 4 vessels; Coastwise Transportation Company, 5 vessels; W. R. Grace & Company, 2 vessels, and many others. Besides these, "Brunswick" refrigerating plants are installed on 40 vessels belonging to the United States Government.

"The Biddle Bulletin" is the title of a monthly publication issued by the Biddle Hardware Company, 514 Commerce street, Philadelphia, Pa. "This is the opening number of *The Biddle Bulletin*—a publication designed to keep our customers abreast of new developments in the monel metal market. Complete information about our stock list will be given in *The Biddle Bulletin*, which will be issued regularly and mailed gratis to those who desire it. Price changes and size changes of monel metal rods, sheets, etc., will be promptly announced, and interesting facts pertaining to new uses of this valuable material will be published from time to time. Monel metal has quickly risen to a position of extreme importance in many fields of industry. Its remarkable resistance to corrosion, combined with a strength equal to steel, and the readiness with which it is machined, have caused its adoption for countless purposes. In most of these instances monel metal has displayed astonishing superiority over metals ordinarily used. Monel metal is a natural alloy—68 percent nickel, 30 percent copper and the remainder iron and manganese. It never rusts, and for all practical purposes is impervious to acid conditions or superheated steam. Possessing a tensile strength much greater than phosphor bronze, it is at the same time so noncorrodible as to outlast that material in many cases by from 50 to 100 percent. We ship monel metal sheets and rods promptly from our Philadelphia stock. Castings are quickly furnished from customers' patterns. Any individual or business concern wishing to be on our monthly stock list should notify us without delay. *The Biddle Bulletin* will then be sent regularly to the address given. Our illustrated booklet on monel metal will be mailed on request. It contains valuable information."

An electric blue-print machine is described in an illustrated catalogue published by the Eugene Dietzgen Company, 218 East Twenty-third street, New York. "You do not have to depend upon time or weather to reproduce your drawings or tracings. It makes no difference whether it is day or night, rain or shine, our electric blue-print machine will give uniform exposure on the sensitized paper, through the equal light radiation in the cylinder."

A steam engine indicator is described in a folder published by the Star Brass Manufacturing Company, 104 East Dedham street, Boston, Mass. "Its simplicity is instantly recognized and its accuracy is the apex of indicator science. Its construction embodies many unique and meritorious features, such as the diameter of the piston, which is one-quarter of one square inch area also, the length of the piston is materially reduced, thereby eliminating friction to a minimum, the reduced area of piston also allows of the use of lighter wire springs, ensuring greater elasticity and marked freedom of operation. The position of the spring is such as to make it readily accessible for quick changes, and the method employed is novel and easily the simplest form produced. By a very novel method of releasing the jam nut under spring the position of atmospheric line is readily adjusted. These instruments have been approved for use on United States Government vessels, and are recommended by the leading mechanical engineers and architects."

A little booklet, entitled *Record Breaking*, has been published by the American Blower Company, Detroit, Mich. This booklet tells of the record-breaking speeds achieved by the United States battleships *Utah* and *Florida* on their trial trips. "Nor are these the only dreadnoughts in the United States navy equipped with our apparatus; the *Delaware* and *North Dakota* carry 'Sirocco' forced draft equipment, and these ships were, until the *Utah* and *Florida* were commissioned, the 'great ships' of the navy. Numerous torpedo boat destroyers, colliers, etc., also carry our fans, to say nothing of the fact that practically the entire British navy and most of the vessels in the other European navies and that of Japan are equipped with 'Sirocco' fans built at Belfast. 'Sirocco' fans would enable you to break all previous records in the economical operation of your boiler plant. Let us figure with you. In any event, let us send you our new Mechanical Draft Catalogue No. 343ME."

The high efficiency of J-M Sea Rings is one of the articles published in the December issue of the *J-M Power Expert*, issued by the H. W. Johns-Manville Company, Madison avenue and Forty-first street, New York. "J-M Sea Rings cannot exert more than 25 percent of the amount of friction that ordinary packings exert on a rod or plunger. In other words, they save 75 percent of the friction—or, rather, power needed to overcome the friction—that is always present where ordinary packings are used. This statement is based on the fact that J-M Sea Rings do not grip or press against the rod except when there is a tendency to leakage or pressure through the box; and then their pressure against the rod is in exact proportion to the pressure against the packing. J-M Sea Rings, therefore, do not press against the rod during the entire forward stroke of an engine when the steam is back of the piston. On the return stroke their pressure drops from the maximum pressure at the beginning of the return stroke to nothing at the end of the stroke, or one-half the amount of pressure against the rod that ordinary packings exert."

A chain hoist with a patented loop hand-chain guide that protects the working parts and adds to its safety, is described in a catalogue issued by the Ford Chain Block & Manufacturing Company, 143 Oxford street, Philadelphia, Pa. "This is the only block that carries a five-year guarantee."

Inclined elevators—continuous motion carriers—which meet every condition of freight transportation from level to level, and which are particularly adapted to the quick and economical handling of freight on steamship docks and piers, and in storage warehouses, freight stations, etc., are described in a catalogue published by the Otis Elevator Company, Eleventh avenue and Twenty-sixth street, New York. Without obligation of any kind the Otis Elevator Company's engineering department will submit plans and estimates of equipment and operation cost of the types best adapted to your requirement. The company states, "Put your freight-moving problems up to us—we offer you a real help and a positive solution."

"Submarine Signals" is the title of a 38-page book published by the Submarine Signal Company, 88 Broad street, Boston, Mass. "After fourteen years of experiment it has been demonstrated that the submarine signal receiving system which we furnish is the only satisfactory one which has been devised. It is an all-water system; that is, receiving tanks filled with water are provided inside the ship to receive the sound coming through the water outside the ship. This principle of receiving submarine signals is fundamental and is fully covered by our patents. To those interested in a more technical discussion of the various methods of receiving submarine signals and their relative efficiency we will gladly forward our special pamphlet, which explains the merits of our all-water system more fully."

The cofferdam for the Government ship lock located at Black Rock Harbor is described in illustrated Bulletin No. 103, published by the Lackawanna Steel Company, Lackawanna, N. Y. "This bulletin on the greatest steel sheet piling work ever undertaken describes in minute details every stage of the cofferdam work, from the preliminary piling tests to the pulling of the piling after the completion of the lock. The engineering features of this work, as discussed herein, offer interesting and useful hints to every engineer or contractor who may have occasion to use steel sheet piling. The chapters containing reports on installation and tensile tests under Government supervision further show conclusively why Lackawanna steel sheet piling enjoys unquestioned supremacy where great strength and easy driving are essentials. Altogether this bulletin is important enough to warrant most careful reading, so send your address for a free copy."

The Morse valve reseating machine, made by the Leavitt Machine Company, or the improved Dexter machine the company now makes, has been used for many years by the Pittsburg Steamship Company, the Southern Pacific Company, the United Fruit Company, the Cleveland Cliffs Company, the Providence Steamship Company, by the British Admiralty, and, in fact, by the merchant marine and the navies of many countries. The manager of one of the largest shipbuilding works in the world stated recently, "Although there are many things useful on board ship, there is nothing more useful, more essential, or better known by marine and naval engineers, or better liked, than the Dexter machine for repairing valves. This machine is fully described and illustrated in Catalogue I-15, a copy of which should be in the hands of every marine engineer, shipbuilder, naval architect and shipowner. It is published by the Leavitt Machine Company, Orange, Mass. A copy will be sent free upon request.

Steam turbines are the subject of a bulletin published by the Connecticut Turbine Manufacturing Company New London, Conn. The special points of superiority claimed by the manufacturer of these turbines are as follows: "A designer, long experienced in the 'small turbine' field, formerly associated with four prominent turbine builders. An improved system of steam distribution and bucketing, efficient and compact in form. Rugged symmetrical design throughout, with liberal shafts, bearings and parts. Flowed bronze wheel buckets, non-destructible, the entire wheel rim in one piece. Flowed bronze return buckets, non-corrosive, in sections detachable from case. Metallic shaft packing water packed and tight at all pressures. A compensating governor, simple, and governs as close as you like. Governor motion bearing ring oiled, which operates the emergency stop if allowed to go dry. An emergency stop, simple and effective, adjustable to different speeds. Absolute lack of oil cups or similar devices that require attention. Interchangeable parts of selected materials most suitable for the duty."

A large and handsome catalogue will be sent upon receipt of 10 cents in stamps, to pay postage, by the Gas Engine & Power Company and Chas. L. Seabury & Company, Con., Morris Heights, N. Y. This company has had twenty-five years' experience in marine construction, and the catalogue should be in the hands of every person interested in engines and boilers.

"Sirocco" mechanical draft fans for marine use are described in publication 343-M E., published by the American Blower Company, Detroit, Mich. The statement is made that these fans will furnish more draft with less power than the ordinary steel plate fan of twice the size.

Direct-connected generating sets for marine purposes are the subject of a catalogue published by Engberg's Electric & Mechanical Works, 5 Vine street, St. Joseph, Mich. These sets are especially guaranteed as to rating, stability and performance, and also to be of the highest development in this line of equipment.

"Toch's Steel Paint Specifications" is the subject of a catalogue issued by Toch Bros., 320 Fifth avenue, New York. "For over two decades red lead has been used on ships of the United States navy. The superdreadnought *New York* was the first ship to use a better paint on the steel hull below the waterline. It was painted with a foundation priming, anti-corrosive coating of Tockolith."

The multiplex slide rule is described in a folder published by the Eugene Dietzgen Company, 218 East Twenty-third street, New York. "The multiplex will save time and annoyance, as it is constructed upon correct mechanical principles. In addition to being made from carefully seasoned and selected stock, assembled and finished by skilled men, it has an automatic adjustment which renders it for all practical purposes perfect."

"File Filosophy" is the title of a booklet published by the Nicholson File Company, Providence, R. I., a copy of which should be in the hands of every user of files. In the manufacture of this company's files is used "the best steel made for the purpose, correctly tempered and made by expert workmen, directed by forty-nine years' experience. Nicholson files, made in 3,000 styles and sizes, are absolutely unexcelled in cutting power, durability and uniformity."

Instructions for stopping leaks in screw-thread pipe joints are given in a folder published by the Smooth-On Manufacturing Company, Jersey City, N. J.

"Keystone Grease" is the title of an illustrated booklet published by the Keystone Lubricating Company, Department V, Philadelphia, Pa. "This booklet comprises a general treatise on the several densities or consistencies of Keystone grease. It outlines and describes the difference between their general make-up as well as thoroughly designating the general class of machinery which each one is physically appropriate to lubricate. There is also described the proper and correct method by which each density should be used and applied to the various classes of machinery bearings. Correct application contributes very considerably to the achievement of maximum good results from the use of Keystone grease; so we, therefore, earnestly impress upon the engineer or person intending to test or use Keystone grease the importance of reading over, thoroughly, this booklet and applying the grease according to instructions."

TRADE PUBLICATIONS

GREAT BRITAIN

Shirley's patent inclined stabilizing planes for ships are described in a circular published by Frederick Shirley, 151-A Hillington street, Kennington, Park, London, S. E. The application of these stabilizing planes to passenger steamers and smaller vessels will neutralize the tendency to sea sickness and prevent the cargo from shifting, which is always liable to occur through pitching and rolling in a rough seaway. When applied to destroyers or torpedo boats they will have a marvelously steady power, enabling the guns to be more accurately laid and in accelerating the speed due to the planes holding up the foremost part of the vessel, and by keeping the propeller submerged racing of the engines will be eliminated. The greater velocity of the vessel through the water will materially increase its stability by the rush of water imprisoned under the planes forming a cradle of one, two, three or four stages, according to the number of planes used. The vessel may then be assumed to be gliding in this cradle, formed by the water trapped under the inclined planes, giving the vessel rigidity unobtainable by any other method. These stabilizing planes can be easily fixed to any ship."

High-speed gear hobbing machines are described and illustrated in a 48-page catalogue, published by Humpage, Thompson & Hardy, Jacob street, Bristol. "Have you ever stopped to think how many gear wheels are constantly running in your machine shop? If you have you must have realized what an important part gearing plays in almost every machine. Suppose for a moment that the teeth of all these thousands of wheels were imperfectly shaped, what would be the result? The noise in your machine shop would be deafening, pointing at once to loss of efficiency, waste of power and greater wear and tear. Are you satisfied that your gears are as silent and efficient as they might be? The rapid and accurate production of silent running gear wheels is a subject which must be of interest, directly or indirectly, to every engineer. What was good enough fifty years ago could not be tolerated in these days of high-speed machinery, and so we can trace a steady evolution of gearing from the time when people were content to use wheels with cast teeth. First came the machine-molded tooth, and next the teeth were cut from the solid blank by means of a single tooth fly cutter. Later still the fly cutter was replaced by a disk milling cutter with machine-relieved teeth, whose form is unchanged by grinding. For a long time the teeth cut in this way were quite good enough to meet all requirements, but the development of high-speed machinery and the ever-increasing demands for silence and efficiency, combined with cheapness, have now made this method out of date. The outcome of these more exacting demands is the gear hobbing machine."

Direct-acting steam pumps for all services and pressures are described in a catalogue of 60 pages published by Clarke, Chapman & Company, Ltd., Gateshead-on-Tyne. "In putting forward our latest designs of direct-acting steam pumps (Woodeson's patent), we wish to call attention to a few of the considerations by which we have been moved. We have fully recognized that a steam pump must be simple, economical and reliable, and have worked to this end; also the vital parts, viz.: the steam valves should be of a form which may be easily made and fitted in any part of the world at a trifling cost. In the latest Woodeson patent pump this has been accomplished, and at the same time maximum economy of steam, under all conditions, has always been kept in mind, and actual results have been fully up to our expectations. We have no hesitation in recommending these pumps for every service where a direct-acting pump can be used, and for boiler feeding we are confident they are without an equal, both as regards reliability, economy and smoothness of working. We are supplying these pumps in daily increasing numbers, both for marine and land services, and records of most satisfactory results are always reaching us. For marine work and for land work, when a condenser is used, automatic float control gear is mostly fitted; and we strongly recommend it wherever it is possible to use it, especially for land work, where its adoption is not as general as it might advantageously be. By this means the water is automatically fed to the boilers as fast as it comes from the air pump, and apart from reducing the amount of attention required the steady feed to the boiler promotes easy steaming."

"Eclipse" electric heaters are described in a 30-page catalogue published by the Electric & Ordnance Accessories Railways Company, Ltd., Aston, Birmingham. "It is no exaggeration to say that electricity is revolutionizing the work of the world. On every hand we come in contact with applications; in industrial, commercial and domestic life, its unseen forces are effecting a miraculous transformation. Its ubiquity is unquestionable, and its pre-eminence, in whatever sphere it is employed, without dispute. Of the many boons which it has bestowed on mankind, the greatest so far is, perhaps, the electric light, which is now to be found in practically every modern household and which is recognized by competent authorities to be superior in every way to all other illuminants. Of recent years electricity has been successfully applied as a heating agent, and the wonderful progress which has been made in this direction is due entirely to the highly satisfactory results which have been obtained. The public is beginning to realize that coal fires, in addition to occasioning much unnecessary work in the household, and being productive of many vexations in the shape of dust, smoke, dirt, etc., including damage to internal decorations, are extremely wasteful, the percentage of the heat developed, which is usefully employed, being extremely small. Gas and steam heaters admittedly pollute the atmosphere and effect its humidity, and without doubt the only method of heating which ensures absolutely pure and wholesome heat being obtained is by the use of electric heaters, in which there is no combustion whatever and from which there are no injurious products to undermine the health and destroy the comfort of those breathing the heated atmosphere."

"Disc Grinding" is the title of a catalogue published by Perkins & Company, Ltd., Lord Street Engineering Works, Leeds. "The use of disk grinders is rapidly developing as their wonderful time and labor-saving properties become more widely known and appreciated.. The ordinary emery wheel machine requires no argument to ensure for it a place in every workshop. Its adaptability for rough shaping at a fraction of the cost of filing is familiar to everyone. There is, however, in every shop an immense amount of work for which the ordinary emery machine is of no use. Such work is generally finished by milling or shaping, followed by draw-filing, or scraping to a surface plate, with heavy expenditure of time and labor. This work can almost invariably be done more perfectly, and in a fraction of the time, by means of a disk grinding machine, which is practically a rotary fire, traveling at 2 miles per minute. The steel disks can be run at double the speed at which it would be safe to run an emery wheel."

Diesel Engine Company, Ltd., General Buildings, Aldwich, London, W. C., has issued a circular called "Last Word in Power Production." "The Diesel engine, now universally recognized as the most efficient type of internal-combustion engine, owes its development in this country to the Diesel Engine Company, Ltd., London—the original owners of the patents taken out by Dr. Rudolf Diesel in 1892. The success of this engine has been almost phenomenal, owing to the fact that it uses cheap fuel oil in such small quantities that it competes favorably with every other form of motive power. The sources of supply of this cheap fuel oil have abundantly increased within the last few years, and it can now be obtained in almost every part of the world where power is required. Owing to large developments in the oil fields of the world, particularly in America, Mexico, Chili, Russia, Borneo, Burmah, Persia, and more recently in Egypt, it is evident that the supply will for many years be equal to the demand, and no fears of a shortage and consequent increase in price need be contemplated. Within the comparatively brief period which has elapsed since the Diesel engine was first placed on the market its progress, notwithstanding the opposition and conservatism with which a new invention has to contend, has been remarkable, and at the present time engines aggregating more than 600,000 brake-horsepower are in use. The results of tests show that the consumption of fuel oil in the Diesel engine is 0.40 pounds per brake-horsepower-hour in the larger, and 0.46 pounds in the smaller sizes, and in actual practice it is proved that this excellent figure is maintained under working conditions. With oil at 40s. per ton the fuel costs are .09 pence per brake-horsepower per hour, or 0.126 pence per kilowatt per hour."

Machine tools are described in a 40-page catalogue published by Tangyes, Ltd., Cornwall Works, Birmingham. In submitting this catalogue of machine tools, Tanges, Ltd., would like to draw attention to the substantial character of the tools shown. They were among the first to make an exhaustive study, and carried out a long series of tests, with a view to the manufacture of machine tools to meet the present-day requirements of high-speed steels, etc. As is well known, to give good work a machine tool must be not only accurate in regard to its dimensions, but substantial in its construction, to eliminate as far as possible vibration, which is so destructive to the tool. The power that is required bears an almost direct proportion to the amount of metal removed—kind for kind—and it will be readily seen that machines should of necessity be of stronger and stiffer construction, if only on account of the power that is passed through them in dealing with the heavier cuts. It is also the opinion of many that high-speed steels have not yet reached a stage of finality, and it is well in putting down new machines to ensure that they are of substantial construction, and so avoid, as far as possible, expensive replacements in keeping pace with such developments. Tanges, Ltd., have exceptional facilities for producing machine tools of a satisfactory character, in that they are manufacturers of a wide range of machinery, and have their machines constantly under their own supervision in working conditions, and are enabled to embody such points as are of actual service without introducing too much *finesse* into their construction, which latter often proves a disadvantage in actual use and tends to weaken the machine. Tangyes, Ltd., would like to add that (under the names of Tangyes Machine Tool Company, Ltd., and The Tangye Tool & Electric Company, Ltd.) they have been manufacturers of machine tools for over forty years, and as they are constantly revising and improving their standard designs to bring them up to modern requirements, they invite inquiries for all kinds of heavy machine tools for railway and engineering establishments."

Valves of every descripton, for water, steam and air, are described in catalogues issued by Alley & MacLellan, Ltd., Glasgow.

Fittings and tools for steam, water and gas are described in a profusely illustrated catalogue of 180 pages, published by E. Bennett & Son, Ltd., Aldgate, East Chambers, London, E. "In compiling this catalogue it has been our aim to present as fully as a book of this size permits all the fittings required by a pipe fitter, but should it happen that you can find no illustration of your special requirement, please send us a specification and we would be pleased to give you a quotation. We undertake to supply any article in malleable iron, soft cast iron, brass and gunmetal in a finished condition or as a rough casting. Our works are the largest in the world for this special business. They possess practically unlimited facilities for turning out the greatest variety of highest class work of this description. We especially invite in the following, your attention to some of the advantages to be obtained by the uses of these fittings and the few suggestions as to selection."

Patent bevel wheel shaping machines are described in a circular published by Greenwood & Batley, Ltd., Leeds. "These machines are made in three standard sizes for shaping the teeth of bevel and mitre wheels, working from an enlarged copy, or former, of the tooth to be cut, and are extensively used by government departments, gear cutting specialists, machine builders, etc. We have a number of machines in constant operation in our own gear cutting department, which may be inspected at work. The chief characteristic of the machines and their advantage over other types is that they will produce teeth which are theoretically correct in form, and therefore more efficient, whilst they are not restricted to any one particular form of tooth. In their latest form, as herein illustrated, they are fully automatic in all their movements, being equipped with automatic dividing mechanism, and an automatic trip which ensures uniformity in the depth of tooth. The machines require little attention from the operator beyond the fixing of the work and the setting of the tools, so that one workman is able to operate several machines advantageously."

BUSINESS NOTES

AMERICA

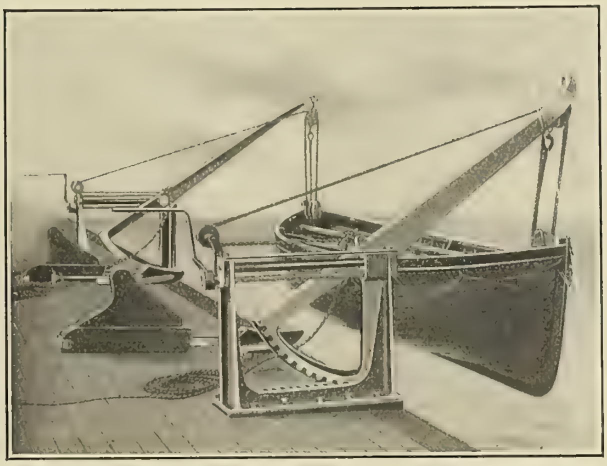
MR. PETER F. FLAVIN, former general salesman for the Monarch Tool Company, from which position he recently resigned, is now connected with the Chicago Pneumatic Tool Company, with headquarters at Birmingham, Ala.

THE INDEPENDENT PNEUMATIC TOOL COMPANY, Chicago, Ill., has appointed Walter A. Johnson manager of its Atlanta, Ga., office, to succeed John J. Keefe, deceased. Mr. Johnson has been connected with the Independent Company's Pittsburg office for several years, and is well equipped to take up his new duties.

AMONG THE VERY RECENT PURCHASES OF TATE, JONES & COMPANY'S rivet forges are the E. Keeler Company, Kennicott Company, American Bridge Company, Hockensmith Wheel & Mine Car Company, Standard Oil Company, Western Gas Construction Company, McMyler Interstate Company and the Lake Shore Engine Works. This company's rivet forges are being shipped all over the world.

J. H. WILLIAMS & COMPANY, 63 Richard street, Brooklyn, N. Y., manufacturer of drop forgings, have opened an office and warehouse at 40 South Clinton street, Chicago, Ill., in charge of Mr. Charles E. Hathaway, who has represented the firm in Chicago for some years. It will be Mr. Hathaway's aim to carry at all times a sufficient stock of Williams' many drop-forged specialties to accommodate the immediate needs of the firm's customers in that part of the country.

THE ANNUAL MEETING of the board of directors of the Independent Pneumatic Tool Company was held in Chicago on Dec. 3. The usual quarterly dividend of 2½ percent was declared payable Jan. 10, 1913, to stockholders of record on Dec. 31, 1912. The annual statement shows an increase in the company's sales of 31 percent over the previous year. In order to meet this increased demand for Thor air tools additional factory buildings are now under construction at Aurora, Ill., which, with equipment, will cost several hundred thousand dollars. Mr. James Buchanan Brady, president of the company, made a special trip from New York to Chicago to attend this meeting.



A FREE SAMPLE OF "PALMETTO" PACKING will be sent upon application to Greene, Tweed & Company, 109 Duane street, New York. "Palmetto" packing gives long service under high-pressure conditions because of its great structural strength. The layer upon layer construction of heat-resisting materials gives it the power of endurance. The lubricant in each single strand keeps it soft and pliable. A working sample put to test in your own engine room will convince you. Send for it.

A REDUCTION IN PRICE.—The Joseph Dixon Crucible Company, Jersey City, N. J., makes the interesting announcement that the selling price of its Silica-Graphite "One Quality Only" paint is reduced. The company makes this reduction because the decrease in the price of linseed oil, which is used as the vehicle, enables it to do it, and because it is the company's aim at all times to give customers any benefit possible in reduction of price of materials. "This well-known paint, which has been the standard for nearly fifty years with leading railroads and manufacturing plants as a maintenance paint, is a perfect, long-service protector of all exposed steel and metal surfaces."

MR. W. R. HAYNIE, United States representative of Carels Freres, Ghent, Belgium, the largest exclusive builders of the Diesel engine in Europe, was instructed by the directors to secure for them in America a works manager for the Ghent plant, which plant at the present time is being doubled. After thorough consideration of the matter, Mr. D. G. Baker, works manager of the Olds Motor Works, Lansing, Mich., and who was formerly works manager of the Lake & Knowles Steam Pump Company, Cambridge, Mass., was secured to take this position. Mr. Baker has just returned from a trip to Ghent, where he concluded arrangements and a contract as works manager of Carels Freres' plant at Ghent, and is now preparing to sail to Europe.

THE ALEXANDER MILBURN COMPANY, Baltimore, Md., has just moved to new premises at 1420-22-24-26 West Baltimore street. For some time past the company have been operating under considerable difficulty on account of having insufficient space. Less than two years ago the company increased its space materially by taking in an additional building at the former location on Lombard street, but it is now necessary to seek new and larger quarters. The new premises were purchased in late summer, and have been converted into a most modern building for the factory and offices. The Milburn Company is extensive manufacturers of various kinds of acetylene apparatus, including portable lights, house lighting machines, oxy-acetylene welding and cutting plants and the steam acetylene system for locomotive headlights.

THE STOCK HOLDINGS formerly owned by Mr. Henry Hess, of the Hess-Bright Manufacturing Company, Philadelphia, Pa., in the company, have been purchased outright by the Deutsche Waffen und Munitionsfabriken, Berlin, Germany, Mr. Hess retiring to devote himself to his various other interests. The controlling ownership remains in America in the hands of Mr. T. E. Bright, former vice-president and treasurer, who will direct the future policies. "We are making extremely large additions and improvements to our German works—already the most extensive in existence—also desirable improvements in our facilities for American distribution of a constantly-increasing output. We wish to assure you, in this connection, of our full realization of the importance of unfaltering ambition at all times toward betterment, and that no expenditure of effort or money is being spared to effect advancement in all branches of our business."

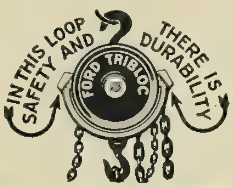
NELSON VALVE COMPANY UNDER NEW MANAGEMENT.—The Yarnall-Waring Company, formerly at 1109 Locust street, Philadelphia, Pa., announces its removal to Chestnut Hill, Philadelphia, having assumed the management of the factory and sales of the Nelson Valve Company. The identities of both companies will be maintained as before. The management and officers of Yarnall-Waring Company remain unchanged. The management of the Nelson Valve Company is changed by the following appointments: D. Robert Yarnall, vice-president and general manager; Bernard G. Waring, vice-president and manager of sales. "Hardly enough time has yet elapsed since they assumed control to lay out a definite policy in regard to the complete undertaking. One thing they have decided, however, and decided for all time—that is the quality that has won for Nelson valves their present high standing with the engineering fraternity—their superior design and workmanship shall not be changed in one detail, unless a still further way to improve them can be found."

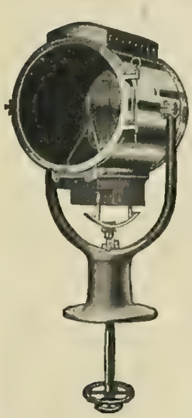
THE H. W. JOHNS-MANVILLE COMPANY announces the appointment of Mr. C. S. Berry as manager of the Atlanta, Ga., office, located at 31½ South Broad street. To facilitate delivery in the South a stock of roofings, packings, pipe coverings and other J-M asbestos, magnesia and electrical products is carried at this above address. This office also employs a force of workmen experienced in the application of J-M products.

A SATISFACTORY BOILER COMPOUND.—P. A. Meehan, 134 Maiden Lane, New York, has received, among many other testimonial letters, the following from the chief engineer of the New York & Staten Island Electric Company: "Your letter of April 27, in regard to the action of the boiler compound you furnished us, at hand. In reply would say that it has given us satisfactory results. We have tried a great many different kinds of compounds and chemicals to overcome the scale in our boilers, but have been unable to remove same until now. The scale in the boilers was in the neighborhood of ⅛ inch thick, and this was almost entirely removed in a few months with the use of your compound. We are at the present time able to keep the boilers in good shape with very little trouble. We consider your compound a great 'find,' as the water on Staten Island is the worst water for boiler use in the country. If you desire to have anybody see the action of same, I would be pleased to show them the inside of our boilers at any time."

THE ROSS SCHOFIELD COMPANY, 39 Cortlandt street, New York, manufacturer of the Ross Schofield system of circulation for steam boilers, reports a large increase of business during the past six months, within which period the following steamship companies gave orders for the installation of this system in the boilers of their vessels: North Eastern Railway, 2 dredges; Holland-American Line, 4 passenger and 14 cargo vessels; P. & O. Campbell Company, 2 vessels; Gloucester & Sharpness Dock Company, 14 tugboats; Coastwise Transportation Company, collier *Norfolk;* Ward Line steamship *Mexico;* Messrs. W. Cory & Sons, 4 colliers; Spillers & Bakers, 5 vessels; Thos. Harrison, Ltd., 2; New England Coal & Coke Company, collier *Newton;* George Clark, Ltd., 3 vessels; Palmer's Shipbuilding Company, 2; Golden Horn Steamship Company (Constantinople), 8; D. W. Henderson, 2; N. E. Marine Engineering Company, 2; J. P. Corry & Co., 3; Shire Line, 3 cargo and 3 tugboats; American Petroleum Company; Uranium Steamship Company; British India S. N. Company; Great Eeastern Railway; Leetham & Sons, Dunsmuir & Jackson; Richardson & Westgarth; David Rowan & Company; Scrutton & Company; Dublin Steam Trawling Company; Jones & Son; The Severn & Canal Carrying Company; Sirket-Hairie (Constantinople); Frantelli Accan (Genoa); Cassa di Resparuico (Genoa); Fred. Drughorn & Company, one vessel each. In at least ten of these the orders came from previous users of this system, as will be seen by referring to the list of users published by the Ross Schofield Company.

GRADING MANILA FIBER.—One of the features which enter into the individuality of any manufacturer of rope is that of regrading in order that he may get a uniform quality in each of his products. This is made necessary because of the great variety of designations applied to Manila hemp as placed on the market. Because of these variations it is impossible for the manufacturer to combine selections of different marks in the right proportions to give the desired results unless he resorts to regrading. To get this reliability or results requires a thorough knowledge of fibers, a large stock, and special storage facilities. In order that large quantities of fiber may be constantly at hand and proper selection made, the Plymouth Cordage Company, North Plymouth, Mass., has warehouses capable of storing large quantities of fiber for months at a time and maintains a system of fiber examination and classification by its own experts, which, with warehouse records, insure each bale being put to the particular use its quality fits it for. The important question of quality is determined when the hemp first reaches the Plymouth Cordage Company. The carloads of fiber from Boston, New York, Seattle and other ports are brought directly alongside the warehouses, and after the hemp has all been transferred to the platforms every mark is carefully gone over. Bales are opened, the hanks laid out flat, the fiber minutely examined and each mark given a new grading. This examination is conducted directly from the manufacturing standpoint, and is entirely in addition to the one made on the dock as a check upon the commercial grading previously described. The expert ability to judge fiber and the constant care required can be imagined by our readers from the fact that single shipments frequently contain as many as seventy-five marks.





MARINE SOCIETIES.

AMERICA.

AMERICAN SOCIETY OF NAVAL ENGINEERS
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SOCIETY OF NAVAL ARCHITECTS AND MARINE ENGINEERS
29 West 39th Street, New York.

NATIONAL ASSOCIATION OF ENGINE AND BOAT MANUFACTURERS
29 West 39th Street, New York City.

UNITED STATES NAVAL INSTITUTE
Naval Academy, Annapolis, Md.

GREAT BRITAIN.

INSTITUTION OF NAVAL ARCHITECTS
5 Adelphi Terrace, London, W. C.

INSTITUTION OF ENGINEERS AND SHIPBUILDERS IN SCOTLAND
39 Elmbank Crescent, Glasgow.

NORTHEAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS
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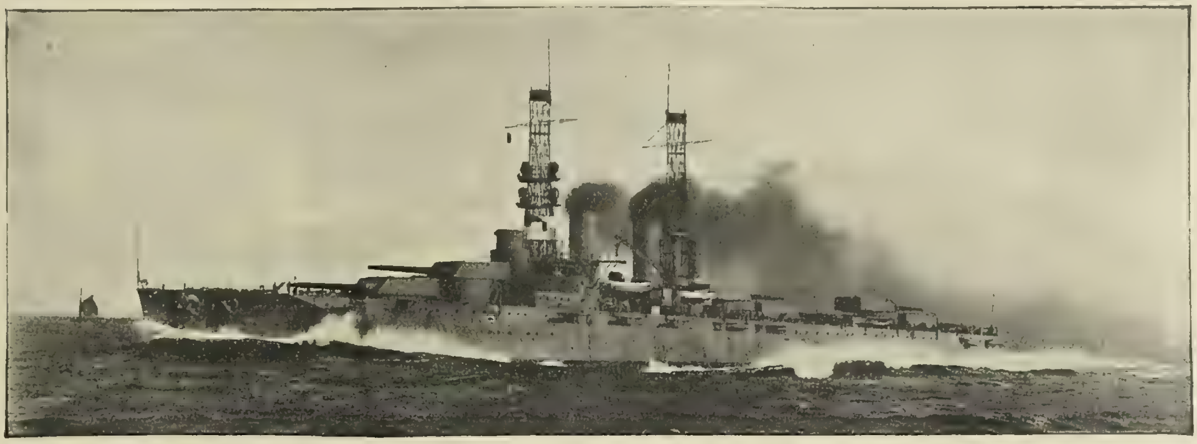
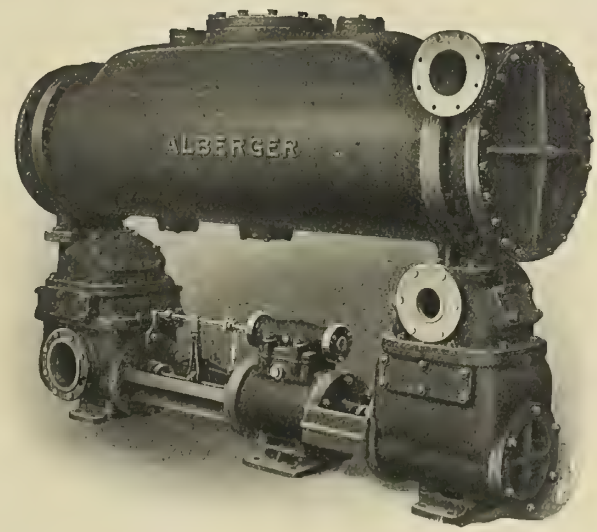
National Secretary—M. D. Tenniswood, 308 Vine St., Camden, N. J.

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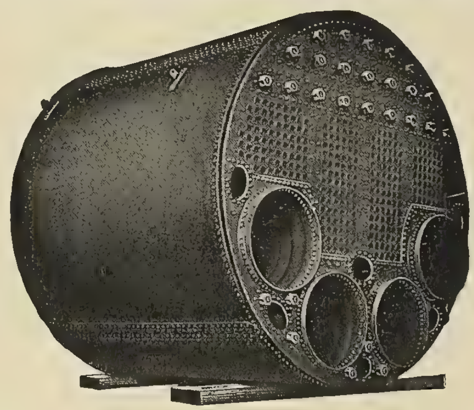

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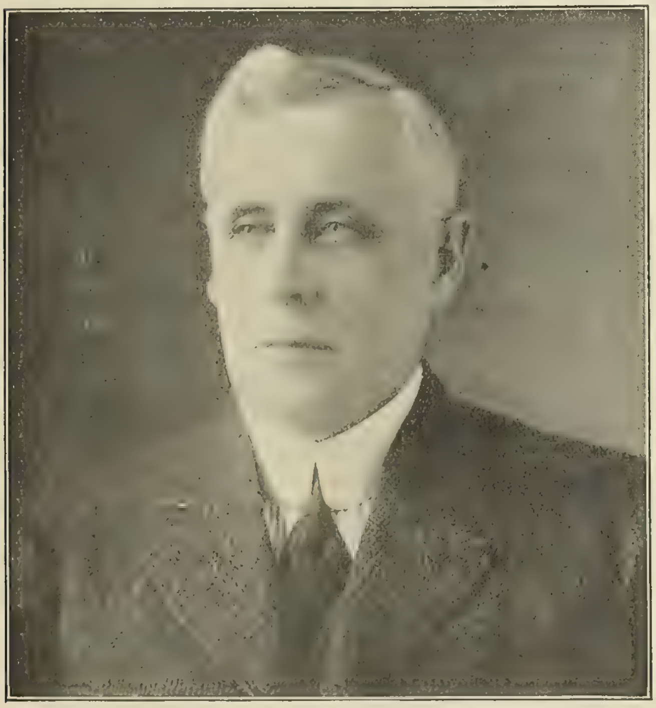

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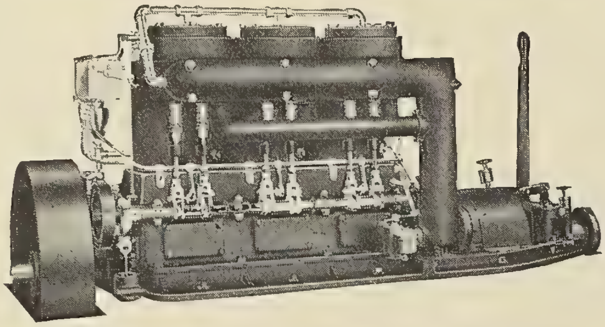

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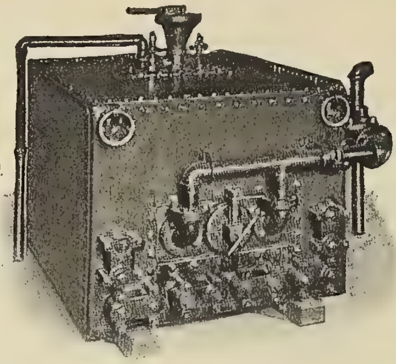

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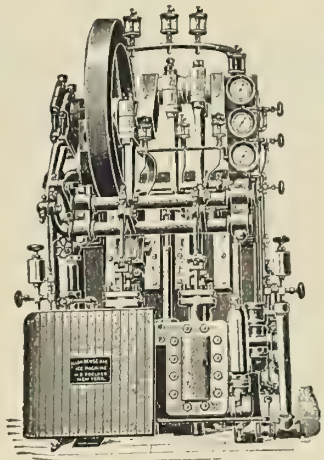

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Stow Mfg. Co., Binghamton, N. Y.

FLOATING DRY DOCKS—See DRY DOCKS.

FLUE CLEANERS—See BOILER FLUE CLEANERS.

FLUE CUTTERS—See BOILER FLUE AND TUBE CUTTERS.

FORCED DRAFT—See also BLOWERS.
American Blower Co. and Sirocco Engineering Co., Detroit, Mich.
De Laval Steam Turbine Co., Trenton, N. J.
General Electric Co., Schenectady, N. Y.
Sturtevant Co., B. F., Hyde Park, Mass.

FORGES.
Sturtevant Co., B. F., Hyde Park, Mass.

FORGINGS, BRONZE—See also DROP FORGINGS.
Erie Forge Co., Erie, Pa.
Hyde Windlass Co., Bath, Me.
Sizer Forge Co., Buffalo, N. Y.

FORGINGS, OPEN HEARTH STEEL.
Erie Forge Co., Erie, Pa.
Sizer Forge Co., Buffalo, N. Y.

FORGINGS, VANADIUM.
Sizer Forge Co., Buffalo, N. Y.

FREIGHT ELEVATORS FOR DOCKS AND WHARVES.
Otis Elevator Co., New York.

FROSTPROOF COVERINGS.
Ferdinand, L. W., & Co., Boston, Mass.

FUEL ECONOMIZERS.
Griscom-Russell Co., New York.
Power Specialty Co., New York.
Sturtevant Co., B. F., Hyde Park, Mass.

FUEL OIL BURNERS.
Schutte & Körting Co., Philadelphia, Pa.

FURNACES—Also see CORRUGATED FURNACES.
Continental Iron Works, New York.

FUSIBLE PLUGS.
Griscom-Russell Co., New York.
Lunkenheimer Co., Cincinnati, Ohio.

GALLEYS—See RANGES.

GAS BLOWERS AND EXHAUSTERS.
American Blower Co., Detroit, Mich.
Schutte & Körting Co., Philadelphia, Pa.
Sturtevant Co., B. F., Hyde Park, Mass.

GASKETS—Also see PACKING.
Griscom-Russell Co., New York.
Johns-Manville, H. W., Co., New York.
Katzenstein & Co., L., New York.
New York Belting & Packing Co., Ltd., New York.
Peerless Rubber Mfg. Co., New York.
Power Specialty Co., New York.
Smooth-On Mfg. Co., Jersey City, N. J.

GASOLINE ENGINES—Also see LAUNCHES AND YACHTS; KEROSENE ENGINES; OIL ENGINES; DIESEL ENGINES.
Bridgeport Motor Co., Bridgeport, Conn.
Mietz, A., New York.
Standard Motor Construction Co., Jersey City, N. J.
Wolverine Motor Works, Bridgeport, Conn.

GAS ENGINE SPECIALTIES.
Lunkenheimer Co., Cincinnati, Ohio.
Powell, Wm., Co., Cincinnati, Ohio.
Star Brass Mfg. Co., Boston, Mass.

GAS PRODUCERS—See MARINE GAS PRODUCERS.

GATE VALVES—See VALVES.

GAUGE COCKS.
Jerguson Gage & Valve Co., Boston, Mass.
Lunkenheimer Co., Cincinnati, Ohio.
McNab & Harlin Mfg. Co., New York.
National Tube Co., Pittsburg, Pa.
Powell, Wm., Co., Cincinnati, Ohio
Star Brass Mfg. Co., Boston, Mass.

GAUGES—See STEAM GAUGES; also WATER GAUGES.

GAUGE GLASSES.
- Jerguson Gage & Valve Co., Boston, Mass.
- Lunkenheimer Co., Cincinnati, Ohio.
- McNab & Harlin Mfg. Co., New York.
- Watertown Specialty Co., Watertown, N. Y.

GENERATORS—See ELECTRIC PLANTS.

GLOBE VALVES—See VALVES.

GLUE—LINOLEUM, MARINE, SHIP, YACHT, WATERPROOF.
- Ferdinand, L. W., & Co., Boston, Mass.

GONGS.
- National Tube Co., Pittsburg, Pa.

GOVERNORS—See PUMP GOVERNORS.

GRABS—See DREDGING MACHINES.

GRAPHITE.
- Dixon, Jos., Crucible Co., Jersey City, N. J.

GRATE BARS.
- Griscom-Russell Co., New York.

GREASE—See LUBRICANTS.

GREASE CUPS—See LUBRICATORS.
- Albany Lubricating Co., New York.
- Cook's Sons, Adam, New York.
- Griscom-Russell Co., New York.
- Lunkenheimer Co., Cincinnati, Ohio.
- McNab & Harlin Mfg. Co., New York.

GREASE EXTRACTORS.
- Griscom-Russell Co., New York.

GYPSEYS.
- American Engineering Co., Philadelphia, Pa.
- Hyde Windlass Co., Bath, Maine.

HAMMERS, PNEUMATIC—See PNEUMATIC TOOLS.

HARDWARE—See MARINE HARDWARE; also CHANDLERY STORES.

HARDWOOD—See LUMBER.

HAWSERS—See WIRE ROPE.

HEATERS—BATH, LAVATORY, SHOWER.
- Alberger Pump and Condenser Co., New York.
- Sands, A. B., & Son Co., New York.
- Schutte & Körting Co., Philadelphia, Pa.

HEATING AND VENTILATING APPARATUS.
- American Blower Co., Detroit, Mich.
- Schutte & Körting Co., Philadelphia, Pa.
- Sturtevant Co., B. F., Hyde Park, Mass.

HELMETS, SMOKE AND AMMONIA.
- Hayward, S. F., & Co., New York.

HEMP—See TWINE.

HOISTING ENGINES.
- American Engineering Co., Philadelphia, Pa.
- Hyde Windlass Co., Bath, Maine.
- Lidgerwood Mfg. Co., New York.

HOISTS, CHAIN—See CHAIN HOISTS.

HOISTS, ELECTRIC—See ELECTRIC HOISTS.

HOSE—See AIR HOSE.
- Eureka Fire Hose Mfg. Co., New York.
- Hayward, S. F., & Co., New York.
- Independent Pneumatic Tool Co., Chicago and New York.
- New York Belting & Packing Co., Ltd., New York.

HOSE COUPLING.
- Eureka Fire Hose Co., New York.
- Hayward, S. F., & Co., New York.
- Independent Pneumatic Tool Co., Chicago and New York.
- McNab & Harlin Mfg. Co., New York.
- National Tube Co., Pittsburg, Pa.

HOSE NOZZLES.
- Hayward, S. F., & Co., New York.
- McNab & Harlin Mfg. Co., New York.
- Morse, Andrew J., Son, Inc., Boston, Mass.

HOSE REELS AND RACKS.
- Hayward, S. F., & Co., New York.

HUMIDIFIERS.
- Griscom-Russell Co., New York.
- Tillotson Humidifier Co., Providence, R. I.

HYDRAULIC FITTINGS.
- Lunkenheimer Co., Cincinnati, Ohio.
- McNab & Harlin Mfg. Co., New York.
- National Tube Co., Pittsburg, Pa.
- Powell, Wm., Co., Cincinnati, Ohio.
- Schutte & Körting Co., Philadelphia, Pa.

HYDRAULIC MACHINERY—RIVETERS, PUNCHES, SHEARS.
- Niles-Bement-Pond Co., New York.

ICE MACHINES—See REFRIGERATING PLANTS.

INCLINED ELEVATORS FOR DOCKS AND WHARVES.
- Otis Elevator Co., New York.

INDICATOR CONNECTIONS.
- Lunkenheimer Co., Cincinnati, Ohio.

INDICATORS—STEAM AND GAS ENGINE.
- Lunkenheimer Co., Cincinnati, Ohio.
- Powell Co., The, Wm., Cincinnati, Ohio.
- Star Brass Mfg. Co., Boston, Mass.

INDUCED DRAFT.
American Blower Co., Detroit, Mich.
Sturtevant Co., B. F., Hyde Park, Mass.

INJECTORS.
Lunkenheimer Co., Cincinnati, Ohio.
Powell Co., The, Wm., Cincinnati, Ohio.
Schutte & Körting Co., Philadelphia, Pa.

INSURANCE—MARINE AND FIRE.
Hutchinson, Rivinus & Co., New York and Philadelphia.

INTERLOCKING RUBBER TILING.
Griscom-Russell Co., New York.
New York Belting & Packing Co., Ltd., New York.

IRON CEMENT.
Smooth-On Mfg. Co., Jersey City, N. J.

JACKS—PNEUMATIC.
Independent Pneumatic Tool Co., Chicago and New York.

JOURNAL BEARINGS—See THRUST BEARINGS.

JUTE.
Columbian Rope Co., Auburn and New York.

KEROSENE ENGINES—See also OIL ENGINES AND DIESEL ENGINES.
Mietz, A., New York.
Wolverine Motor Works, Bridgeport, Conn.

LATHES, CRANK SHAFT.
Niles-Bement-Pond Co., New York.

LAMPS, SIGNALS, AND FIXTURES.
Carlisle & Finch Co., Cincinnati, Ohio.
General Electric Co., Schenectady, N. Y.
Johns-Manville, H. W., Co., New York.

LATHES, ENGINE.
Niles-Bement-Pond Co., New York.

LATHES, TURRET.
Niles-Bement-Pond Co., New York.

LAUNCHES AND YACHTS—See also SHIPBUILDERS AND DRY DOCK COMPANIES.
Bridgeport Motor Co., Bridgeport, Conn.
Marine Iron Works, Chicago, Ill.
Standard Motor Construction Co., Jersey City, N. J.
Ward, Chas., Engineering Works, Charleston, W. Va.
Welin Marine Equipment Co., Long Island City, N. Y.

LAVATORIES—FOLDING, STATIONARY, STATEROOM.
Sands, A. B., & Son Co., New York.

LAVATORY AND BATH HEATERS.
Griscom-Russell Co., New York.
Schutte & Körting Co., Philadelphia, Pa.

LIFE BOATS AND RAFTS.
Welin Marine Equipment Co., Long Island City, N. Y.

LIFE GUNS.
Hayward, S. F., & Co., New York.

LIFE PRESERVERS.
Ferdinand, L. W., & Co., Boston, Mass.
Welin Marine Equipment Co., Long Island City, N. Y.

LIFE-SAVING DEVICES.
Hayward, S. F., & Co., New York.
Welin Marine Equipment Co., Long Island City, N. Y.

LIGHTS.
Milburn, Alex. C., Co., Baltimore, Md.

LIGHT BUOYS.
Milburn, Alex. C., Co., Baltimore, Md.

LIGHTHOUSE APPARATUS.
Milburn, Alex. C., Co., Baltimore, Md.

LINOLEUM CEMENT.
Ferdinand, L. W., & Co., Boston, Mass.

LIQUID GLUE, WATERPROOF.
Ferdinand, L. W., & Co., Boston, Mass.

LOG REGISTERS.
Schuette Recording Compass Co., Manitowoc, Wis.
Welin Marine Equipment Co., Long Island City, N. Y.

LUBRICANTS.
Albany Lubricating Co., New York.
Cook's Sons, Adam, New York.
Dixon, Jos., Crucible Co., Jersey City, N. J.
Power Specialty Co., New York.

LUBRICATING COMPOUND.
Albany Lubricating Co., New York.
Cook's Sons, Adam, New York.

LUBRICATORS.
Albany Lubricating Co., New York.
Cook's Sons, Adam, New York.
Griscom-Russell Co., New York.
Lunkenheimer Co., Cincinnati, Ohio.
McNab & Harlin Mfg. Co., New York.
Powell, Wm., Co., Cincinnati, Ohio.
Schutte & Körting Co., Philadelphia, Pa.

LUMBER.
Vrooman, S. B., Co., Philadelphia, Pa.

MACHINE TOOLS—See TOOLS, MACHINE.

MAHOGANY—See LUMBER.

MANGANESE BRONZE CASTINGS—Also see BRONZE.
Griscom-Russell Co., New York.
Hyde Windlass Co., Bath, Maine.
Lunkenheimer Co., Cincinnati, Ohio.
Phosphor-Bronze Smelting Co., Philadelphia, Pa.

MAGNESIA COVERINGS.
Johns-Manville, H. W., Co., New York.

MANILA AND SISAL ROPE—See ROPE; also CORDAGE.

MARINE BOILER COMPOUNDS—See BOILER COMPOUNDS.

MARINE CABLEWAYS.
Lidgerwood Mfg. Co., New York.

MARINE ENGINES—See ENGINES, PROPELLING.

MARINE FORGINGS—See FORGINGS.

MARINE GAS PRODUCERS.
Griscom-Russell Co., New York.
Marine Producer Gas Power Co., New York.
Wolverine Motor Works, Bridgeport, Conn

MARINE GLUE.
Ferdinand, L. W., & Co., Boston, Mass.

MARINE HARDWARE.
Griscom-Russell Co., New York.
Biddle Hardware Co., Philadelphia, Pa.
Ferdinand, L. W., & Co., Boston, Mass.

MARINE LAMPS—See LAMPS.

MARINE RAILWAY BUILDERS—See RAILWAY DRY DOCKS.
Crandall Engineering Co., The, East Boston, Mass.

MARINE RANGES—See RANGES.

MARINE REFRIGERATION—See REFRIGERATING PLANTS.

MARINE SIGNALS—See SIGNALS.

MARINE SUPPLIES.
Ferdinand, L. W., & Co., Boston, Mass.

MASTS, STEEL.
Welin Marine Equipment Co., Long Island City, N. Y.

MECHANICAL DRAFT.
American Blower Co., Detroit, Mich.
Sturtevant Co., B. F., Hyde Park, Mass.

MEGAPHONES—See CHANDLERY STORES.

METAL WORKING TOOLS—See TOOLS, MACHINE.

METALLIC PACKING—Also see PACKING.
Katzenstein, L., & Co., New York.
Power Specialty Co., New York.
United States Metallic Packing Co., Philadelphia, Pa.

METRES, ELECTRIC.
General Electric Co., Schenectady, N. Y.
Weston Electrical Instrument Co., Waverly Park, Newark, N. J.

MILLING MACHINES.
Niles-Bement-Pond Co., New York.

MINERAL WOOL—See NON-CONDUCTING COVERING.

MONEL METAL.
Biddle Hardware Co., Philadelphia, Pa.

MONITOR NOZZLES—See HOSE NOZZLES.

MOORING ENGINES.
American Engineering Co., Philadelphia, Pa.
Hyde Windlass Co., Bath, Maine.

MOTOR BOATS—See LAUNCHES AND YACHTS.

MOTOR BOAT SUPPLIES.
Ferdinand, L. W., & Co., Boston, Mass.

MOTORS, ELECTRIC.
General Electric Co., Schenectady, N. Y.

MOTORS, GASOLINE—See GASOLINE ENGINES.

MULTIPLE DRILLS.
Niles-Bement-Pond Co., New York.

MULTI-SPEED MOTORS.
Stow Mfg. Co., Binghamton, N. Y.

NAVAL ARCHITECTS—See PROFESSIONAL CARDS.

NEEDLE VALVES—See VALVES.

NIPPLES.
National Tube Co., Pittsburg, Pa.

NON-CONDUCTING COVERING.
Johns-Manville, H. W., Co., New York.

NOZZLES—See HOSE NOZZLES.

NUTS—See BOLTS AND NUTS.

OAKUM.
Baltimore Oakum Co., Baltimore, Md.
Davey, W. O., & Sons, Jersey City, N. J.
Welin Marine Equipment Co., Long Island City, N. Y.

OIL—See LUBRICANTS.

OIL BURNERS, FUEL—See FUEL OIL BURNERS.

OIL CUPS—See LUBRICATORS.

OIL FUEL APPARATUS.
Schutte & Körting Co., Philadelphia, Pa.

OIL ENGINES—See ENGINES, OIL.

OIL GAUGES.
Lunkenheimer Co., Cincinnati, Ohio.
McNab & Harlin Mfg. Co., New York.
Powell Co., The, Wm., Cincinnati, Ohio.
Star Brass Mfg. Co., Boston, Mass.

OIL POLISH—See METAL POLISH.

OIL PUMPS.
Lunkenheimer Co., Cincinnati, Ohio.
Star Brass Mfg. Co., Boston, Mass.

OILING SYSTEMS—Also see LUBRICATORS.
Albany Lubricating Co., New York.
Cook's Sons, Adam, New York.
Lunkenheimer Co., Cincinnati, Ohio.
Powell Co., Wm., Cincinnati, Ohio.
Schutte & Körting Co., Philadelphia, Pa.

PACKING—Also see METALLIC PACKING.
Greene, Tweed & Co., New York.
Johns-Manville, H. W., Co., New York.
New York Belting & Packing Co., Ltd., New York.
Peerless Rubber Mfg. Co., New York.
Power Specialty Co., New York.

PACKING, ASBESTOS.
Johns-Manville, H. W., Co., New York.

PAINT—Also see GRAPHITE; also MARINE PAINT.
Dixon, Jos., Crucible Co., Jersey City, N. J.

PATENT ATTORNEYS—See ATTORNEYS, PATENT.

PETROL ENGINES—See GASOLINE ENGINES.

PHOSPHOR BRONZE CASTINGS.
Griscom-Russell Co., New York.
Hyde Windlass Co., Bath, Maine.
Lunkenheimer Co., Cincinnati, Ohio.
Phosphor-Bronze Smelting Co., Philadelphia, Pa.

PILING—STEEL.
Lackawanna Steel Co., Buffalo, N. Y.

PIPE COVERING—See NON-CONDUCTING COVERING.

PIPE CUTTING AND THREADING MACHINES.
Niles-Bement-Pond Co., New York.

PIPE FLANGES—See FLANGES.

PIPE UNIONS.
Dart, E. M., Mfg. Co., Providence, R. I.
Lunkenheimer Co., Cincinnati, Ohio.
McNab & Harlin Mfg. Co., New York.
National Tube Co., Pittsburg, Pa.
Powell Co., The, Wm., Cincinnati, Ohio.

PIPE WRENCHES.
McNab & Harlin Mfg. Co., New York.
Williams & Co., J. H., Brooklyn, N. Y.

PLANERS, STANDARD METAL WORKING AND ROTARY.
Niles-Bement-Pond Co., New York.

PLANERS, SHIP PLATE.
Niles-Bement-Pond Co., New York.

PLANIMETERS.
Star Brass Mfg. Co., Boston, Mass.

PLATE-BENDING ROLLS.
Niles-Bement-Pond Co., New York.

PLUMBAGO—Also see GRAPHITE.
Dixon, Jos., Crucible Co., Jersey City, N. J.

PLUMBING—Also see CHANDLERY STORES.
Davidson, M. T., Co., New York.
Sands, Alfred B., & Son Co., New York.

PNEUMATIC SEPARATORS.
Griscom-Russell Co., New York.
Sturtevant Co., B. F., Hyde Park, Mass.

PNEUMATIC TOOLS—Also see AIR COMPRESSORS.
Independent Pneumatic Tool Co., Chicago and New York.

POPPET VALVES—See VALVES.

PORTABLE CYLINDER BORING BARS—See CYLINDER BORING BARS.

PORTABLE DRILLS.
General Electric Co., Schenectady, N. Y.
Stow Mfg. Co., Binghamton, N. Y.

POWER PUNCHES AND SHEARS—See TOOLS, MACHINE.

PRESSURE REGULATORS.
Ashton Valve Co., Boston, Mass.
Lunkenheimer Co., Cincinnati, Ohio.
Lytton Mfg. Corp., Franklin, Va.
McNab & Harlin Mfg. Co., New York.
Powell Co., Wm., Cincinnati, Ohio.
Star Brass Mfg. Co., Boston, Mass.
Watertown Specialty Co., Watertown, N. Y.

PRODUCERS—See MARINE GAS PRODUCERS.

PROFESSIONAL CARDS.
Cox & Stevens, New York.
Decker, Delbert H., Washington, D. C.
Donnelly, W. T., New York.
Whitaker, Morris M., Nyack-on-Hudson, N. Y.

PROJECTORS—See SEARCHLIGHTS.

PROPELLER WHEELS.
Donnelly, W. T., New York.
Hyde Windlass Co., Bath, Me.
Roelker, H. B., New York.
Sheriffs Mfg. Co., Milwaukee, Wis.
Trout, H. G., Co., Buffalo, N. Y.

PROPELLING ENGINES—See ENGINES, PROPELLING.

PUMPS.
Alberger Pump and Condenser Co., New York.
Blake & Knowles Steam Pump Works, New York.
Davidson, M. T., Co., New York.
De Laval Steam Turbine Co., Trenton, N. J.
Griscom-Russell Co., New York.
Hyde Windlass Co., Bath, Maine.
Kingsford Foundry & Machine Works, Oswego, N. Y.
Sands, A. B., & Son Co., New York.
Terry Steam Turbine Co., Hartford, Conn.
Wheeler Condenser and Engineering Co., Carteret, N. J.

PUMPS, DREDGING.
Terry Steam Turbine Co., Hartford, Conn.

PUMPS, MARINE GLUE.
Ferdinand, L. W., & Co., Boston, Mass.

PUNCHING MACHINES AND SHEARING MACHINES, HYDRAULIC POWER AND HAND.
Niles-Bement-Pond Co., New York.

PYROMETERS.
H. & M. Division of the Taylor Instrument Cos., Rochester, N. Y.

QUADRANT DAVITS—See DAVITS.

RAFTS—See LIFE BOATS AND RAFTS.

RAILWAY DRY DOCKS.
Crandall Engineering Co., East Boston, Mass.

RANGE FINDERS.
Nicholson Ship Log Co., Cleveland, Ohio.
Schuette Recording Compass Co., Manitowoc, Wis.

RANGES.
Sands, A. B., & Son Co., New York.

RASPS.
Nicholson File Co., Providence, R. I.

REAMERS.
Morse Twist Drill & Machine Co., New Bedford, Mass.

REAMERS—PNEUMATIC.
Independent Pneumatic Tool Co., Chicago and New York.

RECORDING COMPASSES.
Nicholson Ship Log Co., Cleveland, Ohio.
Schuette Recording Compass Co., Manitowoc, Wis.

REDUCING VALVES—See VALVES.

REDUCING WHEEL.
American Steam Gauge and Valve Mfg. Co., Boston, Mass.

REFLEX WATER GAUGES.
Jerguson Gage & Valve Co., Boston, Mass.

REFRIGERATING ENGINEERS—See ENGINEERS, CONSULTING.

REFRIGERATING PLANTS.
Brunswick Refrigerating Co., New Brunswick, N. J.
Roelker, H. B., New York.

REGRINDING VALVES—See VALVES.

RELEASING GEAR.
Welin Marine Equipment Co., Long Island City, N. Y.

RELIEF VALVES—See VALVES.

RESEATING MACHINES—See VALVE RESEATING MACHINES.

REVOLUTION COUNTERS.
Ashton Valve Co., Boston, Mass.

RHEOSTATS.
General Electric Co., Schenectady, N. Y.
Simplex Electric Heating Co., Cambridge, Mass.

RIGGING—See WIRE ROPE.

RIVER BOATS—Also see SHIPBUILDERS AND DRY DOCK COS.
Marine Iron Works, Chicago, Ill.
Merrill-Stevens Co., Jacksonville, Fla.
Ward, Chas., Engineering Works, Charleston, W. Va.

RIVETING MACHINES, HYDRAULIC AND STEAM POWER.
Independent Pneumatic Tool Co., Chicago and New York.
Niles-Bement-Pond Co., New York.

RIVETERS, PNEUMATIC.
Independent Pneumatic Tool Co., Chicago and New York.

ROLLER BEARINGS—See THRUST BEARINGS.

ROLLS, BENDING AND STRAIGHTENING.
Niles-Bement-Pond Co., New York.

ROOFING PAINTS.
Ferdinand, L. W., & Co., Boston, Mass.

ROPE—Also see WIRE ROPE, TRANSMISSION ROPE, and MANILA AND SISAL ROPE.
Columbian Rope Co., Auburn and New York.
Durable Wire Rope Co., Boston, Mass.
Griscom-Russell Co., New York.
Phosphor-Bronze Smelting Co., Ltd., Philadelphia, Pa.
Plymouth Cordage Co., North Plymouth, Mass.

ROTARY BLOWERS—See BLOWERS.

ROWBOATS—See LAUNCHES AND YACHTS.

RUBBER BELTING.
Hayward, S. F., & Co., New York.

RUBBER GOODS—Also see Packing—Also see INTERLOCKING RUBBER TILING.
Griscom-Russell Co., New York.
Hayward, S. F., & Co., New York.
New York Belting & Packing Co., Ltd., New York.
Peerless Rubber Mfg. Co., New York.

RUBBER MATTING CEMENT.
Ferdinand, L. W., & Co., Boston, Mass.

RUBBER TILING—See INTERLOCKING RUBBER TILING.

RUBBER VALVES—See VALVES, RUBBER.

SAFETY VALVES—See VALVES.

SANITARY FITTINGS—See PLUMBING.

SANITARY PUMPS—See PLUMBING.

SEARCHLIGHTS.
Carlisle & Finch Co., Cincinnati, Ohio.
General Electric Co., Schenectady, N. Y.

SENTINEL VALVES—See VALVES.

SEPARATORS—PNEUMATIC—See PNEUMATIC SEPARATORS .

SHAFTING—HOLLOW, SEAMLESS STEEL.
National Tube Co., Pittsburg, Pa.

SHAFT STEEL—See STEEL SHAFTING.

SHALLOW-DRAFT RIVER BOATS—See RIVER BOATS. Also SHIPBUILDERS AND DRY DOCK COMPANIES.

SHEARING MACHINES, HYDRAULIC, STEAM POWER AND HAND.
Niles-Bement-Pond Co., New York.

SHEATHING METAL—See YELLOW METAL; also BRASS AND COPPER.

SHEETING, ASBESTOS.
Johns-Manville, H. W., Co., New York.

SHIPBUILDERS AND DRY DOCK COMPANIES—See also RIVER BOATS.
Bath Iron Works, Bath, Maine.
Fletcher, W. & A., Co., Hoboken, N. J.
Fore River Shipbuilding Co., Quincy, Mass.
Krajewski-Pesant Corporation, Havana, Cuba.
Marine Iron Works, Chicago, Ill.
Marvel, T. S., Shipbuilding Co., Newburg, N. Y.
Merrill-Stevens Co., Jacksonville, Fla.
Newport News Shipbuilding & Dry Dock Co., Newport News, Va.
Seattle Construction & Dry Dock Co., Seattle, Wash.
Tietjen & Lang Dry Dock Co., Hoboken, N. J.
Ward, Chas., Engineering Works, Charleston, W. Va.

SHIP CHANDLERS—See CHANDLERY STORES.

SHIP ELEVATORS—See MARINE ELEVATORS.

SHIP FITTINGS.
Ferdinand, L. W., & Co., Boston, Mass.
Griscom-Russell Co., New York.

SHIP GLUE—See MARINE GLUE.

SHIP LOGS AND SPEED INDICATORS.
Schuette Recording Compass Co., Manitowoc, Wis.

SHIP STORES—See CHANDLERY STORES.

SHIPYARDS—See SHIPBUILDERS.

SHOWER BATHS—See PLUMBING.

SLOTTING MACHINES.
Niles-Bement-Pond Co., New York.

SMOOTH-ON.
Smooth-On Mfg. Co., Jersey City, N. J.

SOOT BLOWERS.
Diamond Power Specialty Co., Detroit, Mich.

SPEED INDICATORS FOR SHIPS, YACHTS AND MOTOR BOATS.
Schuette Recording Compass Co., Manitowoc, Wis.

STEAM ACETYLENE LIGHTING SYSTEMS.
Milburn, Alex. C., Co., Baltimore, Md.

STEAM ENGINE INDICATORS—See INDICATORS.

STEAM ENGINES—See ENGINES.

STEAM GAUGES.
Ashton Valve Co., Boston, Mass.
Lunkenheimer Co., Cincinnati, Ohio.
Lytton Mfg. Corp., Franklin, Va.
McNab & Harlin Mfg. Co., New York.
Powell Co., Wm., Cincinnati, Ohio.
Star Brass Mfg. Co., Boston, Mass.

STEAM HAMMERS.
Niles-Bement-Pond Co., New York.

STEAM AND HOT-BLAST APPARATUS.
American Blower Co., Detroit, Mich.
Sturtevant Co., B. F., Hyde Park, Mass.

STEAM PUMPS—See PUMPS.

STEAM SEPARATORS.
Griscom-Russell Co., New York.

STEAM SPECIALTIES.
Alberger Pump and Condenser Co., New York.
Ashton Valve Co., Boston, Mass.
Diamond Power Specialty Co., Detroit, Mich.
Griscom-Russell Co., New York.

Jerguson Gage & Valve Co., Boston, Mass.
Lunkenheimer Co., Cincinnati, Ohio.
Lytton Mfg. Corp., Franklin, Va.
McNab & Harlin Mfg. Co., New York.
National Tube Co., Pittsburg, Pa.
Powell, Wm., Co., New York.
Power Specialty Co., New York.
Schutte & Körting Co., Philadelphia, Pa.
Star Brass Mfg. Co., Boston, Mass.
Tillotson Humidifier Co., Providence, R. I.
Watertown Specialty Co., Watertown, N. Y.

STEAM SUPERHEATERS.
Babcock & Wilcox Co., New York.
Power Specialty Co., New York.

STEAM TRAPS.
American Blower Co., Detroit, Mich.
Griscom-Russell Co., New York.
Lytton Mfg. Corp., Franklin, Va.
National Tube Co., Pittsburg, Pa.
Schutte & Körting Co., Philadelphia, Pa.
Sturtevant Co., B. F., Hyde Park, Mass.
Tillotson Humidifier Co., Providence, R. I.

STEAM TURBINES.
Alberger Pump and Condenser Co., New York.
Bath Iron Works, Bath, Maine.
Bryant-Bery Steam Turbine Co., Detroit, Mich.
De Laval Steam Turbine Co., Trenton, N. J.
Fletcher, W. & A., Co., Hoboken, N. J.
Fore River Shipbuilding Co., Quincy, Mass.
General Electric Co., Schenectady, N. Y.
Kerr Turbine Co., Wellsville, N. Y.
Parsons Marine Steam Turbine Co., New York.
Terry Steam Turbine Co., Hartford, Conn.

STEAM TURBINE DYNAMOS.
De Laval Steam Turbine Co., Trenton, N. J.
General Electric Co., Schenectady, N. Y.

STEAMERS, LIGHT-DRAFT, RIVER—See RIVER BOATS.

STEEL BALLS.
Bantam Anti-Friction Co., Bantam, Conn.

STEEL SHEET PILING.
Lackawanna Steel Co., Buffalo, N. Y.

STEEL VALVES—See FORGED STEEL VALVES.

STEERING GEARS.
American Engineering Co., Philadelphia, Pa.
Hyde Windlass Co., Bath, Maine.

STEERING ENGINES.
American Engineering Co., Philadelphia, Pa.
Hyde Windlass Co., Bath, Maine.
Lidgerwood Mfg. Co., New York.
Sheriffs Mfg. Co., Milwaukee, Wis.

STEERING WHEELS.
American Engineering Co., Philadelphia, Pa.
Hyde Windlass Co., Bath, Maine.

STOP COCKS—See VALVES.

STOVES—See RANGES.

STRAIGHTENING ROLLS—See ROLLS.

SUPERHEATERS—See STEAM SUPERHEATERS.

SUPERHEATER TUBES.
National Tube Co., Pittsburg, Pa.

SURFACE CONDENSERS—See CONDENSERS.

SWITCHBOARDS—See ELECTRICAL INSTRUMENTS.

TACKLE BLOCKS—See BLOCKS.

TANKS—COPPER, GALVANIZED IRON.
Griscom-Russell Co., New York.
Sands, A. B., & Son Co., New York.

TARPAULINS.
Wilford Cloth Co., New York.

TEAK—See LUMBER.

THERMOMETERS—FOR EVERY PURPOSE.
H. & M. Division of the Taylor Instrument Cos., Rochester, N. Y.

THREADING AND CUTTING MACHINES—See PIPE CUTTING AND THREADING MACHINES.

THROTTLE VALVES—See VALVES.

THRUST BEARINGS.
Bantam Anti-Friction Co., Bantam, Conn.

TILING—See INTERLOCKING RUBBER TILING.

TOILET ACCESSORIES.
Sands, A. B., & Son Co., New York.

TOOLS, MACHINE.
Niles-Bement-Pond Co., New York.
Stow Mfg. Co., Binghamton, N. Y.

TOOLS, MACHINISTS' AND CARPENTERS—See BENCH TOOLS.

TOWING HOOKS AND CHOCKS.
American Engineering Co., Philadelphia, Pa.

TOWING MACHINES.
American Engineering Co., Philadelphia, Pa.

TRANSMISSION ROPE—See ROPE.

TRAPS—See STEAM TRAPS.

TUBES—See BOILER TUBES; also BRASS AND COPPER.

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TUBE CUTTERS—See BOILER TUBE CUTTERS.

TUGS—See SHIPBUILDERS.

TURBINES—See STEAM TURBINES.

TURNING ENGINES.
American Engineering Co., Philadelphia, Pa.

TURRET LATHES—See LATHES, TURRET.

TWINE—See ROPE—Also CORDAGE.
Columbian Rope Co., Auburn, N. Y.
Plymouth Cordage Co., North Plymouth, Mass.

TWIST DRILLS.
Morse Twist Drill & Machine Co., New Bedford, Mass.

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VACUUM TRAPS.
Griscom-Russell Co., New York.
Lytton Mfg. Corp., Franklin, Va.

VALVE RESEATING MACHINES.
Leavitt Machine Co., Orange, Mass.

VALVES—Also see RUBBER VALVES AND WATER VALVES.
Ashton Valve Co., Boston, Mass.
Griscom-Russell Co., New York.
Jerguson Gage & Valve Co., Boston, Mass.
Lunkenheimer Co., Cincinnati, Ohio.
Lytton Mfg. Corp., Franklin, Va.
McNab & Harlin Mfg. Co., New York.
National Tube Co., Pittsburg, Pa.
Powell, Wm., Co., Cincinnati, Ohio.
Power Specialty Co., New York.
Schutte & Körting Co., Philadelphia, Pa.
Star Brass Mfg. Co., Boston, Mass.

VALVES — BALANCED THROTTLE VALVES AND QUADRANT VALVES FOR SHIP ENGINES.
Schutte & Körting Co., Philadelphia, Pa.

VALVES, WATER.
Continental Iron Works, Brooklyn, N. Y.
Jerguson Gage & Valve Co., Boston, Mass.
Lunkenheimer Co., Cincinnati, Ohio.

VARNISH—See PAINT.

VENTILATING FANS—See BLOWERS.

VENTILATORS.
Sands, A. B., & Son Co., New York.

VERTICAL PUMPS—See PUMPS.

VOLTMETERS—See ELECTRICAL INSTRUMENTS.

WATER CLOSETS—PUMP WATER CLOSETS—See PLUMBING.

WATER COLUMNS.
Jerguson Gage & Valve Co., Boston, Mass.
McNab & Harlin Mfg. Co., New York.
Lunkenheimer Co., Cincinnati, Ohio.
National Tube Co., Pittsburg, Pa.
Star Brass Mfg. Co., Boston, Mass.
Watertown Specialty Co., Watertown, N. Y.

WATER GAUGES AND ALARMS.
Jerguson Gage & Valve Co., Boston, Mass.
Lunkenheimer Co., Cincinnati, Ohio.
McNab & Harlin Mfg. Co., New York.
National Tube Co., Pittsburg, Pa.
Watertown Specialty Co., Watertown, N. Y.

WATERPROOF CANVAS—See CANVAS, WATERPROOF.

WATERPROOF LIQUID CEMENT.
Ferdinand, L. W., & Co., Boston, Mass.

WATERPROOF LIQUID GLUE.
Ferdinand, L. W., & Co., Boston, Mass.

WATERPROOF PAINT.
Dixon, Joseph, Crucible Co., Jersey City, N. J.
Ferdinand, L. W., & Co., Boston, Mass.

WATERTUBE BOILERS—See BOILERS.

WATER VALVES—See VALVES, WATER.

WHARF DROPS.
American Engineering Co., Philadelphia, Pa.

WHISTLES.
Ashton Valve Co., Boston, Mass.
Lunkenheimer Co., Cincinnati, Ohio.
McNab & Harlin Mfg. Co., New York.
Powell Co., The Wm., Cincinnati, Ohio.
Star Brass Mfg. Co., Boston, Mass.

WHITE METAL
Griscom-Russell Co., New York.
Phosphor-Bronze Smelting Co., Philadelphia, Pa.

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Hyde Windlass Co., Bath, Me.
Lidgerwood Mfg. Co., New York.

WINCHES—See WINDLASSES.

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American Engineering Co., Philadelphia, Pa.
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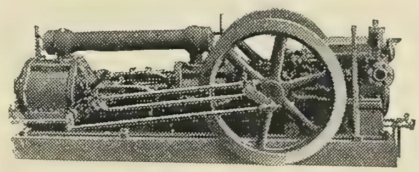
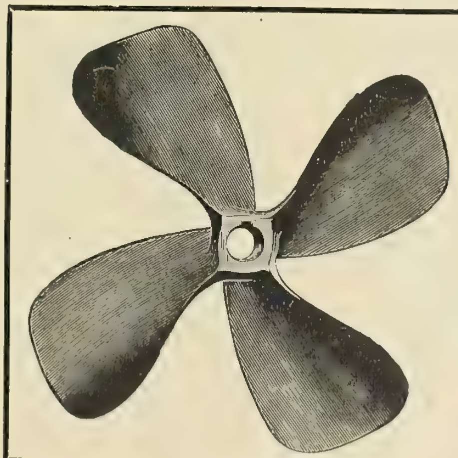
Independent Pneumatic Tool Co., Chicago and New York.

WRENCHES—Also see PIPE WRENCHES.
McNab & Harlin Mfg. Co., New York.
Williams & Co., J. H., Brooklyn, N. Y.

YACHT GLUE—See MARINE GLUE.

YACHTS—See LAUNCHES AND YACHTS; also SHIPBUILDERS.



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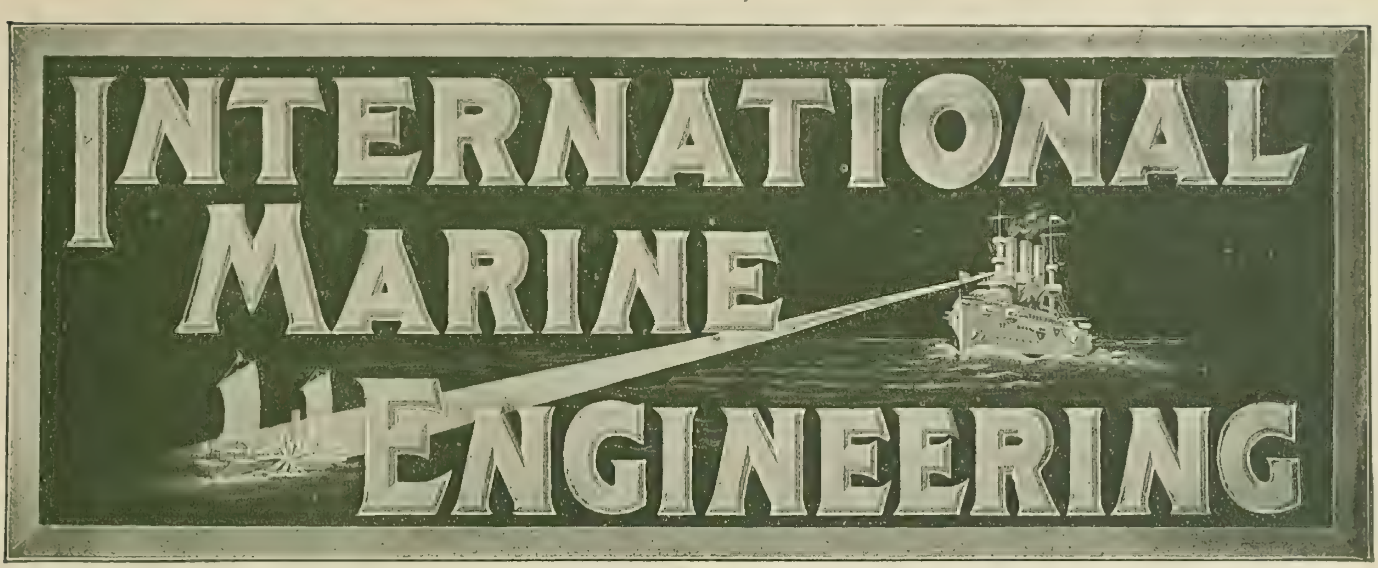

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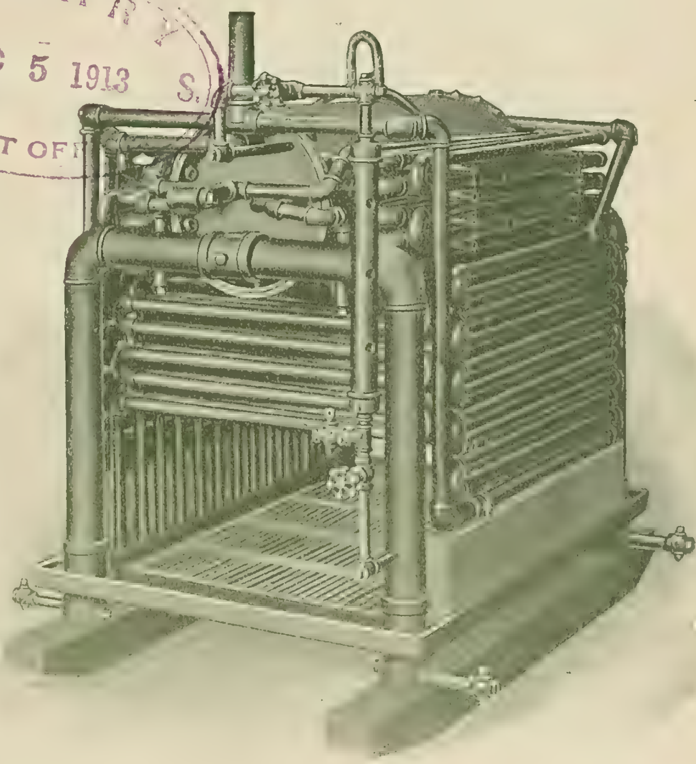

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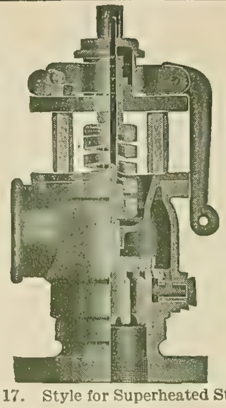

No. 17. Style for Superheated Steam

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NEW YORK St. John's House, London, Eng. CHICAGO

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Steam Windlass, Steam Steering Engine and Screw Gear, Steam Coaling Winches, Electric Capstan, Electric Winch and Ash Hoist Engines

MANUFACTURED BY

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This Company is also furnishing Windlasses, Steering Gears and other Auxiliaries for the Battleships "MORENO" and "RIVADAVIA," now under construction in this country for the Argentine Republic.

DURABILITY AND STRENGTH

combined with the most improved design and high grade workmanship make

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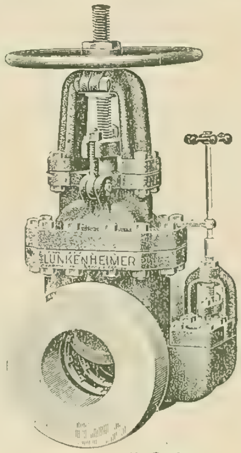
the leaders of their line.



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The iron used is made according to our own formula and has a tensile strength of 25,000 pounds per square inch.

All parts subjected to wear are renewable and are made of a good grade of bronze composition containing a high percentage of copper and tin.

The line consists of Globe, Angle, Cross, Check, Gate, Pop Safety, Relief, Blow-off, Non-return Safety Boiler Stop Valves, etc.

They are made in all standard sizes, and in several weights, the heaviest being for working pressures up to 250 pounds.

For superheated steam and severe service these valves can be had made of "Puddled" Semi-steel, having a tensile strength of 35,000 pounds per square inch, or for extreme conditions of service, pressure and superheat, they are made of Cast Steel, the tensile strength of which is about 80,000 pounds per square inch.

Specify and insist upon securing genuine Lunkenheimer make. Do not accept substitutes—they are never as good as the genuine. Your local dealer can furnish them; if not, write us.

Write for Catalogue.

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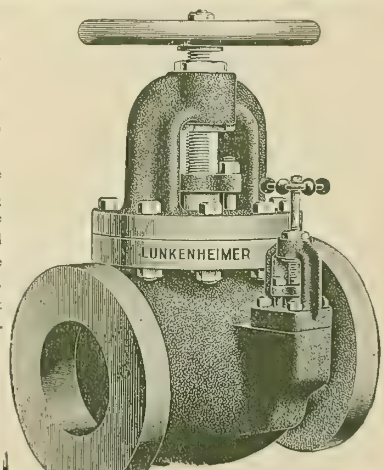

"Samson" Globe Valve

13-25

International Marine Engineering

DECEMBER, 1913

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LONDON
CHRISTOPHER STREET
FINSBURY SQUARE, E. C.

Circulation Manager, H. N. Dinsmore, 37 West Tremlett St., Boston, Mass.
Branch Office: Boston, 643 Old South Building, S. I. Carpenter.
Entered at New York Post Office as second-class matter.

NEW YORK
WHITEHALL BUILDING
17 BATTERY PLACE

Notice to Advertisers.—Changes to be made in copy, or in orders for advertising, must be in our hands not later than the 20th of the month, to insure the carrying out of such instructions in the issue of the month following. If proof is to be submitted, copy must be in our hands not later than the 15th of the month.

TRADE PUBLICATIONS.

AMERICA

Don't throw away your valves—reseat them. How you may do this is told in Catalogue I-16 published by the Leavitt Machine Company, Orange, Mass. All of our readers interested in the subject should send for a free copy of this catalogue.

"Tobin Bronze" is the title of a 32-page booklet published by the American Brass Company, Ansonia, Conn. "We furnish 'Tobin Bronze' in the following forms: Turned and straight pump piston rods and yacht shafting; rolled plates for rudders, centerboards, pump cylinder linings; condenser tube sheets, fin keels and yacht plates, etc.; flat, round, square and hexagonal bars; bars for forgings, boilers and pump linings, bushings, etc."

J-M Boiler Preservative vs. Boiler Scale is the subject of a booklet published by the H. W. Johns-Manville Company, Madison avenue and Forty-first street, New York. The statement is made that when this boiler preservative is fed into a boiler, it is attracted by the heated steel surface to a much greater degree than is the scale or scale-forming elements. It is said to get underneath the scale next to the boiler, thus causing the scale to become loosened and fall off, so that it may be blown or washed out. The company states that it will send one drum of J-M boiler preservative for sixty days' free trial, and that unless results satisfactory to you are produced no charge will be made for the quantity used in making the test.

"Steel Pressure Blowers" is the title of an illustrated circular, 172-O, published by the B. F. Sturtevant Company, Hyde Park, Boston, Mass. The Sturtevant Company has received the following letter from F. N. Peter & Bro., Newside, Pa.: "In the year '78 we started our foundry and installed a Sturtevant blower, and used it constantly until 1901, when our plant was completely destroyed by fire and, strange to say, up to that time we positively did not spend a cent for repairs, and there was no play in the bearings whatsoever. When we rebuilt the plant in 1902, we again installed the same kind of a blower, and up to the very day and down to this minute we have done nothing to the blower but oiled it. And we are most proud to say that it is in better condition than it was when we received it. Long may the Sturtevant blower live, thrive and prosper."

The "National" spring plug cock is described in a circular published by the National Tube Company, Frick building, Pittsburg, Pa. "The National spring plug cock was designed to overcome the disadvantages of the ordinary style, or through-plug cock. When the plug becomes loose in the ordinary type of cock the workman frequently injures the plug in tightening it. Then, again, should the plug become cemented to the body, it is common practice to loosen the nut and drive up the plug with whatever tools are at hand, no special care being taken to properly adjust the plug afterward. The National spring plug cock has an inverted plug with a spring at the bottom, which constantly presses the plug firmly against the seat. While the plug usually turns easily, should it stick occasionally it may be loosened by a blow on the top, after which it is immediately reseated by the spring. The cap at the bottom is screwed securely into the body, and cannot be tampered with by the workman. These cocks are tested before shipment to 250 pounds cold water pressure and to 125 pounds compressed air pressure under water, and are recommended for 125 pounds working pressure."

The American Ideal steam trap and float valve is described in a catalogue just published by the American Steam Gauge & Valve Manufacturing Company, Boston, Mass. "In introducing the following information to your attention, we desire first of all to have you understand that it is the fixed policy of this company never to market any device that has not first proven to our complete satisfaction and, in varied tests among the largest concerns in the country, its unquestioned superiority over any other device made for the purpose. Consequently, we wish you to feel, and we stand ready at all times to prove, that any new device taken on by us contains features of distinct and superior merit. That is the reason for our securing all rights and contracts to manufacture the American Ideal steam traps and American Ideal float valves formerly owned and made by J. W. Coggshall, under the name of the Tillotson Humidifier Company, of Providence, R. I., and known as the Ideal steam traps and Ideal float valves. We have taken over this line because we have unquestionable evidence that it is the best ever made, in proof of which we submit on another page a partial list of purchasers representative of the very best in our country. That you may understand why we make such conclusive claims about the American Ideal, let us review with you the trap field as our experience has found it."

"Cincinnati Milling Machines" is the title of a handsomely printed and illustrated 128-page catalogue just issued by the Cincinnati Milling Machine Company, a free copy of which will be sent to any of our readers mentioning this magazine.

A new device for holding in side sheets is described in a catalogue published by H. J. Kroscovski, 128 Ferry street, Milwaukee, Wis. This device consists of a holding-on die, forced against a rivet head in a firebox water leg by powerful leverage, which is operated by hand or by pneumatic or hydraulic power. One of these tools will be sent free on thirty days' trial at the manufacturer's expense.

A catalogue of air compressors, air hoists, air cranes, pneumatic and hydro-pneumatic elevators, trolleys, trolley systems and sand blasts has just been published by Curtis & Company Manufacturing Company, St. Louis, Mo. "Engineers of Curtis & Company Manufacturing Company have specialized for twenty years in the field of pneumatic hoisting appliances, and have so developed the simple air cylinder by several patented devices that a new labor-saving power has been given to the industrial world. Curtis air cylinders are virtually straight line motors with wonderful speed control, capable of the widest application to hoisting and conveying problems. They make possible Curtis pneumatic cranes and elevators. Circulars fully describing our appliances furnished on request."

The Hunt Storage Battery Industrial Truck.—The Hunt storage battery industrial truck is built by the C. W. Hunt Company, Inc., West New Brighton, N. Y., and is designed for conveying heavy material around manufacturing plants, steam shop and railroad terminals, etc., where it can be run with the utmost flexibility; can be put on elevators and conveyed to different floors, can be run directly into box cars, which would be well nigh impossible with a system of tracks. These trucks are very compact and have a capacity of approximately 4,000 pounds. With this load the maximum speed is about 5 miles per hour. The storage capacity of the batteries is ample for an ordinary full day's working.

Brownhoist buckets and tubs are described in Catalogue R, just published by the Brown Hoisting Machinery Company, Cleveland, Ohio. "In this catalogue we give descriptions and illustrations of the Brownhoist grab buckets, slag buckets, contractors' grab buckets, shovel buckets, and various kinds of tubs as designed and manufactured by this company. Brownhoist buckets and tubs are being used in practically every part of the world. With this varied line of buckets and tubs we are in a position to solve any bucket or tub problem, no matter what the material may be nor how the bucket is to be handled. We gladly give advice as to what kind of a bucket or tub to use for certain work, and we will submit estimates on receipt of request."

A new flooring composition for ships has been put on the market by Byerly & Sons, 2484 West Fourth street, Cleveland, Ohio. It is described in a catalogue published by that company. This composition is stated to have been used on board the passenger steamer *City of Grand Rapids* and the steamer *Chemung* of the Erie Railroad Lake Line, and to have met every condition vessel owners have been seeking. The composition is an asphalt base, into which stone pulverized to powder and other ingredients are mixed. It is applied boiling hot, and is said to form a perfect bond with either wood, steel or concrete. Being entirely mineral in character, neither heat nor cold, fire nor water have any effect upon it. The greatest merit claimed for, from the ship owners' point of view, is that it cannot be made to crack.

Bars, shapes, plates, sheets, tubes, rivets, boiler shop specialties and boiler shop tools are kept constantly in stock by Joseph T. Ryerson & Son, Chicago, and are described in this company's monthly journal. The following are some of the tools and supplies kept on hand: Bars: Bars, bands, hoops, twisted and cold drawn; shapes: beams, channels, angles, tees, rails, girder sections; plates: universal, tank, flange, firebox steel, floor; sheets: black, galvanized, corrugated, stamping, special; tubes: lapweld, charcoal, seamless, locomotive; rivets and bolts: Burden's iron, boiler tank, structural, tinner's, patch, boiler, carriage, machine, lag screws; boiler shop specialties: Ulster and Ulster special staybolt iron, staybolts, staybolt taps, crabs, crayons, plugs, nozzles, manholes and covers, hangers, lugs, flanges, furnaces, drills, rivet sets; boiler shop tools: Ryerson flue cleaning machines, Otto flue cleaning machines, Ryerson combination hot saw and tube expander, McGrath safe-end machine, Hartz superheater and tube-welding machine, Ryerson pneumatic flue-welding machine, Ryerson flue cutter, Mathews combination tube cutting and cleaning machine, expanders, forges, etc.

General Electric marine engine generating sets are described in circulars published by the General Electric Company, Schenectady, N. Y. The statement is made that these generating sets have been giving reliable service on board ship for many years, and that their simplicity of arrangement, small amount of space occupied, and their freedom from evaporation make them especially valuable in marine work.

A New Method of Sales Analysis.—"One concern making use of the Hollerith punched card system writes: 'We figure that it would cost at least four times as much to furnish the same information by hand that we get with the machines, and it would be impossible to get out the work so early in the month.' This concern uses the system for a great variety of analyses, obtaining information used in conducting business from day to day—information which it would be impossible to get together in time by any other known method. Over 300 business concerns in the United States—mercantile, manufacturing, insurance, transportation and others—are now using this up-to-date system for analyzing their daily, weekly and monthly operations. The above quotation from one client is typical. One of the chief advantages of the new method is stated by another client to be 'the ability to obtain statistics and analyses in many different ways from a single original entry—the punched card.' This ability of the machines to handle satisfactorily all sorts of analyses lies in their power to count combined facts. Each counter adds a different set of figures automatically and simultaneously. A new booklet, 'A Business Compass,' has just been published, in which the uses of the system are described in some detail. Copies may be obtained upon request of the Tabulating Machine Company, 25 Broad street, New York."

The Troike muffler, made by the Troike Muffler & Manufacturing Company, Lorain, Ohio, is described as follows in a circular the company has just issued: "The Troike muffler is the first real improvement on the internal-explosion engine since the Selden patents were granted. The Troike muffler is so simple in construction, and so positive in performance, that it has been pronounced by builders of motor boats, automobile engineers, builders and designers of marine and stationary engines, as well as gas engine users and experts, to be the one perfect muffler. The Troike muffler is the only muffler that positively ends all back pressure. The Troike muffler is the only muffler that positively will prevent loss of power. The Troike muffler actually siphons the burnt gas from the cylinder, thus increasing power without increasing the consumption of fuel. The Troike muffler breaks up the exhaust wave in such a manner as to end the noise by reducing the exhaust to atmospheric pressure and atmospheric temperature by the time it reaches the outlet. The Troike muffler is so constructed that after each explosion in the cylinders of the engine there is a vacuum created within the muffler. This vacuum siphons the burnt gas from the cylinder, leaving it clear for the next charge, thus increasing the compression and permitting the engine to deliver the same number of revolutions as it did before the muffler was applied. In fact, these revolutions are delivered with more power and greater regularity, with a lesser consumption of fuel."

The "Airex," an automatic feed-water air extractor, is described in a catalogue just published by the General Condenser Company, 1239 North Twelfth street, Philadelphia, Pa. "Expensive and dangerous break-downs of boiler plants, due to air entering the boilers, either with the feed water or through leakages in the pipes and feed pumps, have necessitated the construction of apparatus for eliminating the air from the feed water before entering the boiler. Water at 60 degrees F. contains 1½ to 2 percent of air in volume, and this air the apparatus eliminates. The following are its chief advantages: 1. Complete elimination of air from the feed water, and consequently: 2, rusting and corrosion of the boiler; 3, corrosion of the valves and other brass fittings, and 4, shocks in pipe lines are avoided. 5. As the air from the feed water has been eliminated, the quantity of air entering the condenser is reduced, and therefore the capacity of the air pumps can be reduced by that amount. Apparatus formerly known for this purpose were generally constructed so that the air, eliminated from the water, escaped through a valve at the highest point of the air vessel, opened automatically by a float. This principle has been applied to a good many apparatus, but has the disadvantage that the apparatus only works satisfactorily as long as the discharge valve at the top of the air chamber holds tight. As soon as this valve for any reason leaks, and the volume of air from the water is not at least equal to the volume of air leaking through the valve, the water will rise in the air vessel till the same is quite full, and the surface of water, which must essentially be exposed for eliminating the air, is no longer exposed."

Bulletin "W H Y-12," published by the Alberger Pump & Condenser Company, 140 Cedar street, New York, explains why the company claims that Alberger turbine boiler-feed pumps ought to be on board all ships.

The Lalor automatic stop valve for fuel oil users is described in a catalogue published by the Lalor Fuel Oil System Company, 1326 Chestnut street, Philadelphia, Pa. This valve is described as being one that makes the use of fuel oil as safe as coal—"a perpetual fire, life and accident insurance."

Industrial ozonators are described in Bulletin No. 850, published by the Sprague Electric Works, 527 West Thirty-fourth street, New York. The field for the application of ozone may be divided into three general classes: For ventilation and air purification; for use in manufacturing processes; for water purification. "For the practical application of ozone to any of the foregoing uses, the Sprague Electric Works manufacture the industrial ozonator. The essential parts of this equipment are: an ozone generator, a transformer, an air filter and a controlling panel."

A catalogue of inclined elevators for handling freight at steamship docks is published by the Otis Elevator Company, Eleventh avenue and Twenty-sixth street, New York. The Otis Elevator Company reports that within one month it has been called upon to furnish inclined elevators as follows: For the New York Central Lines, New York, 4; Carolina Terminal Company, Charleston, S. C., 4; Old Dominion Steamship Company, Norfolk, Va., 2; Mystic Dock, Boston, Mass., 2; Merchants & Miners' Dock, Savannah, Ga., 2.

"Machine Tool and Machinery Bronzes" is the title of a booklet just issued by the Lumen Bearing Company, Buffalo, N. Y. "Lumen is a strong, hard, white bearing bronze, effective under heavy loads and at high speeds. When fitted in the manner that best practice in the uses of this metal has established, it is one of the most effective bearing materials known. Lumen records show the following applications: Engine lathes, main spindle bearings; multiple spindle automatic screw machines, all bearings; boring mills, vertical slide shoes, pulley bushings; planers, oil rollers, pulley bushings; milling machines, spindle bearings, lead screw nuts, telescopic screws, countershaft and pulley bushings; refrigerating machinery, bearing bushings; traveling cranes, all bearings; rolling mills, plate mill tables; rock drills, piston rings."

Smooth-On Iron Cement No. 7 is described in a catalogue just published by the Smooth-On Manufacturing Company, Jersey City, N. J. This concrete is made for surfacing and stopping leaks in concrete, and is said to have met with great success when used for this purpose.

"Asbestosteel for Roofs and Walls" is the title of a handsomely printed and illustrated catalogue of 54 pages, published by the Asebestos Protected Metal Company, Beaver Falls, Pa. The catalogue states that this company some years ago solved the problem of protecting sheet steel from corrosion without in any way sacrificing the advantages inherent in corrugated sheets for roof and wall construction, by developing a process whereby sheet steel was covered on both sides with a uniform covering of asphalt, this in turn being protected from fire and weather exposure by a layer of pure asbestos felt laid over the asphalt while still hot and soft.

"Lunkenheimer Regrinding Valves" is the title of a handsomely printed booklet, illustrated in colors, just published by The Lunkenheimer Company, Cincinnati, Ohio. "The large sale of Lunkenheimer regrinding valves has demonstrated that steam users appreciate the fact that it is possible to secure in them a reliable valve, which can be repaired without disconnecting pipes, or incurring any expense other than the slight labor involved in regrinding the seating surfaces. When a steam user installs Lunkenheimer valves the expense ends with the purchase of the articles. This is not true with valves in which to secure a new seat bearing it is necessary to purchase extra parts; therefore, as a matter of economy the first cost of Lunkenheimer valves should not be the principal consideration."

"Producer Gas for Power Fuel" is the title of a catalogue published by the Syracuse Industrial Gas Company, Syracuse, N. Y. "The producer plant eliminates danger of explosion, fire and the nuisance of boiler inspection and insurance. The smoke nuisance problem is solved and the expense of chimney saved. The labor of handling coal and ash is only about one-sixth that for a steam plant of equal size. The space required for a producer plant is about half that for a steam plant. Moreover, a high-class engineer is not needed. A careless or incompetent operator does not have the opportunity to waste fuel, and the worst thing that can happen is a stoppage of power for the want of gas. The time necessary for starting up is less than for a steam plant, fifteen or twenty minutes in most plants. The gas power plant shows itself to be an investment rather than an expense, and many installations displace steam plants in excellent condition."

Lunkenheimer iron body valves are among the hundreds of valves of all kinds described and illustrated in a large catalogue published by The Lunkenheimer Company, Cincinnati, Ohio. A copy will be sent to any of our readers upon request.

"H & M" index and recording thermometers are described in illustrated catalogues published by the H & M division of the Taylor Instrument Company, Rochester, N. Y. That they are correct in construction and design is stated to be proved by the fact that of all thermometers of all makes combined used in the United States navy, more than half are made by the Taylor Instrument Company.

Close-quarter piston air drills are described in illustrated Catalogue No. 9, published by the Independent Pneumatic Tool Company, Chicago, Ill. "The neat and compact construction of these drills, together with the design of the mechanical parts, has resulted in their becoming the most successful pneumatic tools ever placed on the market. We will send one of them on trial free to any responsible party."

Fire extinguishing on shipboard is the subject of a pamphlet just published by the Fumigating & Fire Extinguishing Company of America, 29 Broadway, New York. This company has equipped a large number of steamships with its fumigating and fire extinguishing machines. Among many new ones recently equipped are the *Minnesotan, Dakotan, Montanan, Pennsylvanian, Panaman, Washingtonian, Iowan* and *Ohioan*. This machine has been approved by the Department of Commerce and Labor, and ships so equipped do not require other fire extinguishing equipment.

Metallic packings are described in a catalogue just published by the Holmes Metallic Packing Company, Wilkes-Barre, Pa. "A few reasons why the Holmes Patent Improved Metallic Piston Rod and Valve Stem Packing is the best: 1. Made in the very best manner that good workmanship can produce. 2. Made of the best material for purposes of wearing and anti-friction qualities. 3. Less friction on the rod and stem than any other packing made. 4. Will not wear the rod out of round or uneven, score or scratch the rod. 5. Saves oil, for we do not require the rod to be deluged with oil. 6. When once packed good for three years. 7. Saves the eternal and everlasting buying of steam packing. Equally good for steam pumps, and for air compressors cannot be excelled. We have said enough; try it for yourselves. We ask no one to pay for it until they have tried it."

Speed indicators for speed tests of engines, generators, turbines, or any machinery, are described in Catalogue 20-L, published by the L. S. Starrett Company, Athol, Mass.

The Christmas edition of the Eckliff Booklet will be sent to any of our readers upon request by the Eckliff Automatic Boiler Circulator Company, 46 Shelby street, Detroit, Mich. "Raising 160 pounds steam in 45 minutes from cold water is the record of a recent Eckliff installation, and there are many other Eckliffs furnishing like testimony."

Catalogue I. M. has just been issued by the Kerr Turbine Company, Wellsville, N. Y. In this catalogue the statement is made that "Economy" turbines, manufactured by the Kerr Turbine Company, are made to furnish the current for lighting and power on the World's largest fresh water boats, such as the *Seeandbee*, the *City of Detroit III*, and many others.

Filling ice boxes costs a lot of money and wastes valuable time. The Brunswick Refrigerating Company, 130 Jersey avenue, New Brunswick, N. J., explains in a catalogue just published how the refrigerating plant eliminates these losses and enables you to cool your ship's stores, make any quantity of ice and to have cool drinking water.

Lackawanna steel sheet piling is described in an illustrated catalogue published by the Lackawanna Steel Company, Lackawanna, N. Y. According to the catalogue, "Universal recognition of Lackawanna steel sheet piling as a leader is based upon its supremacy in lateral and transverse strength, flexibility of interlock, easy driving qualities and water tightness, as competitive and other tests have demonstrated."

Kewanee Unions are the subject of a catalogue just published by the National Tube Company, Frick building, Pittsburg, Pa. This union has no inserted parts, and it is stated that as a result of long experience the manufacturer is enabled to state positively that although the cost is a little higher at first, the ultimate cost is considerably lower.

Roberts safety watertube boilers are described in a catalogue published by the Roberts Safety Water Tube Boiler Company, 112 Chestnut street, Red Bank, N. J. The statement is made in the catalogue that these boilers are the only ones designed with a view to scientifically arranged heating surfaces, which make it possible to show high efficiency and economy with a low ratio of heating surface to grate surface, and stack temperatures less than the temperature of the steam.

A new fire hose catalogue has just been issued by the Eureka Fire Hose Manufacturing Company, New York. The catalogue states that this company's fire hose is circular woven and uniform, not flat woven like other makes.

Sangamo meters are described in Bulletin No. 36, published by the Sangamo Electric Company, Springfield, Ill. "A very interesting application of Sangamo ampere-hour meters is on the new submarine boats of the United States navy. These boats are operated by gasolene engines when running on the surface, at which time storage batteries are being charged, but when submerged the boat cannot, of course, be propelled by any combustion engine, and is then driven by electric motors drawing energy from the batteries. Sangamore meters are used to measure the total input and output of these large batteries, and separate meters are used to record the electricity taken by the auxiliaries, such as lamps, fans, etc. The introduction of Sangamo meters on the submarines has greatly simplified the problem of keeping the batteries fully charged and in proper operating condition."

TRADE PUBLICATIONS

GREAT BRITAIN

Atlas cleaner and disinfectant, which is stated to be especially valuable for use on board ship, is described in a catalogue published by the Atlas Preservative Company of America, 95 Liberty street, New York, and Windmill Lane Wharf, Deptford, London, S. E. This is described as a highly concentrated and refined compound, which is to be diluted with water according to the work intended, and used for preserving, cleaning and disinfecting wood work.

Electric hand drilling, tapping and reaming machines are described by the Power Plant Company, Ltd., West Drayton, Middlesex, England, in a catalogue just issued. "Universal electric driling machines, Type N½. This machine contains a 6-horsepower motor, and drills holes up to 1¼ inches in wrought iron. The machine rotates round the vertical column as well as round a horizontal axis, so that holes in any direction can be drilled. In consequence of this freedom of movement—feed in any desired direction—this machine is extremely handy on erection work of boilers, constructional iron work, etc. The drilling spindle has a feed of 4⅜ inches. The machine can be supplied without base and column, also on wheels, or with longer column."

Light draft steamers, launches, turbines, engines and boilers are described in a catalogue issued by Alley & MacLellan, Ltd., Sentinel Walks, Polmadie, Glasgow, "The requirements of our clients are so varied, and the conditions relating to draft, speed, cargo and passenger accommodation that they wish fulfilled so widely different, that it would be almost impossible to get a catalogue to meet everyone's wants. Bearing this in mind, we have aimed by illustrating a few of the leading types selected from the boats (about 300) which we have built during the last fifteen years to make this more a book of reference from which our clients may describe the type or modification of type they wish particulars of. We are always glad to give any information to intending purchasers, and to submit drawings, specifications and full particulars of a boat which our experience teaches us will best meet the conditions given in their inquiry. In conclusion, we may say that it would, in many cases, save much correspondence if clients gave very much fuller particulars of their requirements and the conditions under which the boat they require will have to work."

Compasses, sounding machines and nautical specialties are described in a handsomely illustrated and printed catalogue of 100 pages, just published by Dobbie-McInnes, Ltd., 57 Bothwell street, Glasgow. "Most modern standard compasses are practically developments of the original Sir William Thomson compass, which introduced a light card with short needles and a form of suspension then suited to counteract the effect of vibration on the compass card. Subsequent improvements in standard compasses have been on similar lines to keep pace with the greater disturbance or vibration introduced by more modern vessels of higher power and speed. Of existing well-known compasses of this type there are several examples, such as the Dobbie-McInnes and Kelvin form. In the Dobbie-McInnes standard compass the best features of the original Sir William Thomson compass have been retained and are supported by patent improvements in duplex suspension, style of card, lighting and compensating facilities as afterwards described. This compass is unsurpassed by any other compass in point of design and accuracy of workmanship, and has been adopted as standard by many of the largest shipowners."

Brayshaw specialties, such as furnaces, pyrometers, milling cutters, gas producers, blowers, temperature measuring instruments, etc., are described in a catalogue just published by S. N. Brayshaw, 2 and 4 Mulberry street, Hulme, Manchester.

Dermatine valves are the subject of an illustrated catalogue issued by Dermatine Company, Ltd., 93 Neate street, London, S. E. "In many cases engineers have discontinued the use of rubber valves owing to inferior or unsuitable qualities indiscriminately supplied, and have been driven to adopt metallic or other substitutes. The fact of the matter is that the leading rubber manufacturers have not given the attention to the making of valves that it undoubtedly deserves. Without perhaps an exception, they make in this and other countries varying qualities at different prices, leaving it to chance which are sold and used. One quality of Dermatine only is made, and that the best, varying only in toughness and hardness according to the conditions under which the valve has to work, such as lifts, pressures, temperatures, etc. All valves are stamped 'Dermatine,' so that engineers, whether they are at home or abroad, are sure of getting the best possible article if they stipulate for Dermatine when buying or indenting; and this system, particularly during the last five or six years, has tremendously increased the demand for Dermatine valves. Large engineers in this country, the Continent and the Colonies, having had practical experience of their value, are constantly recommending Dermatine valves. Dermatine air pump valves, whether for curved or flat guards, have been used and are recommended by the Edwards Air Pump Syndicate, a fact which proves the particular suitability of Dermatine for this class of work. The Dermatine Company has frequently found that engineers do not use the best form of lift, guard and grating, so it was thought advisable to get an expert in condenser pumps to give the most approved. sections. The experience of the Dermatine Company enables it often to give useful information on matters concerning the life of the valve and the most suitable way of working. Engineers are specially invited to ask any questions on the subject, and an endeavor will always be made by the company to give any information in its power."

BUSINESS NOTES
AMERICA

The Badenhausen Water Tube Boiler Company, of New Jersey, has been incorporated. This company manufactures marine and stationary boilers. The main office is at 39 Cortlandt street, New York.

"Palmetto" packing, made by Greene, Tweed & Company, 109 Duane street, New York, is being used on Great Britain's latest super-dreadnought, the *Thunderer.* Free working samples of this packing will be sent to any engineer upon request.

Among recent contracts closed for Terry turbines for Government work, one covers two 50-kilowatt sets for the United States fuel ship *Kanawha,* building at the Mare Island navy yard, San Francisco. Another includes two 300-horsepower turbines for fire pumps for the Brooklyn navy yard, each running at 2,600 revolutions per minute.

Mr. Harold D. Tompkins, a graduate of Cornell University and formerly associated with the Niles-Bement-Pond Company, of Philadelphia, has accepted the position of mechanical engineer with the Smooth-On Manufacturing Company, of Jersey City, N. J. He has charge of their concrete waterproofing department.

A recent addition to the staff of the centrifugal pump department of the A. S. Cameron Steam Pump Works, New York, is Mr. C. V. Kerr, the organizer of the Kerr Turbine Company, and later with McEwen Bros., of Wellsville, N. Y. Mr. Kerr delivered an interesting address with stereopticon views on "A New Centrifugal Pump with Helical Impeller" at the monthly meeting, 11th inst., American Society of Mechanical Engineers, at their rooms, New York City. Reference to this subject in extended form appeared in the October number of the Journal of the society.

The American Blower Company, Detroit, Mich., has purchased the entire air washer interests, including patent rights, of the McCreery Engineering Company, formerly of Toledo, Ohio, and later of Detroit, Mich. The McCreery company enjoy a universal reputation as engineers and manufacturers of efficient air purifying apparatus. Their earlier efforts were almost exclusively confined to marine work, and later entering the general ventilating field, in which the air purifier now forms an indispensable part of any mechanical ventilating system. The McCreery purifying, cooling and humidifying equipment will hereafter be exclusively manufactured and sold by the American Blower Company, under the trade-mark *"Sirocco."*

The Gardner Governor Company, Quincy, Ill., announces that it has opened a New York office in the Singer building, 149 Broadway.

The Ross Schofield Company, manufacturer of boiler circulators, has moved its office from 39 Cortlandt street to 17 Battery Place, New York.

We are informed by the Carlisle & Finch Company, 234 East Clifton avenue, Cincinnati, Ohio, that most of the boats described in the November issue of International Marine Engineering are equipped with Carlisle & Finch searchlights; that in particular all of those illustrated in Captain Burnside's article are equipped with these searchlights, also the fifteen producer-gas barges for the Alabama & New Orleans Transportation Company, as well as all of the vessels of the Port of Para, Para, Brazil.

In order to properly take care of the big increase in its volume of business, the Baltimore branch of the H. W. Johns-Manville Company, has been compelled to seek larger quarters. The new home of the company is a modern six-story building with floors measuring 47 by 187 feet, located at 207-13 East Saratoga street, which is within two blocks of the postoffice and right in the heart of the business section. It will include an attractive store and up-to-date offices, in addition to large warehouse accommodations. To facilitate the handling of incoming and outgoing shipments there will be a railroad switch running into the building.

The Keystone Lubricating Company, Philadelphia, Pa., announces that the word "Keystone," as applied to greases and lubricating oils, belongs to Augustus C. Buzby, doing business as the *Keystone Lubricating Company,* because of his introduction of his product under that name in 1885. This is the decision of the United States District Court for the Northern District of Illinois. The suit in which the validity of this trade-mark was established was fought between the Keystone Lubricating Company, of Philadelphia, Pa., and a Chicago concern. The court thereupon decided that "the complainant having a valid trade-mark, the defendant had no right to use the word 'Keystone' in its corporate name, so far as the sale of lubricating grease by it is concerned, if the public is thereby misled," and ordered that the Chicago concern should incorporate its lubricating grease business under some other name, or adopt some other plan to avoid infringement.

Mr. Phillip P. Bourne has recently been appointed chief engineer of the Epping-Carpenter Pump Company, with shops at Pittsburg. Mr. Bourne was for eight years chief of the engineering staff at the Blake-Knowles Steam Pump Works, East Cambridge, Mass. This appointment is in line with other recent activities of the Epping-Carpenter Pump Company in strengthening their organizaton and enlarging their plant to handle their rapidly-increasing business, especially in high duty and centrifugal pumping machinery.

A News Item from Bantam.—The Bantam Anti-Friction Company, Bantam, Conn., has moved its Detroit office to room No. 525 Dime Savings Bank building, with telephone connections, so as to be in close touch with all friends and customers in Detroit. Mr. John W. Hill, mechanical and sales engineer, is much pleased with his new quarters, and cordially invites all of the friends of the Bantam Anti-Friction Company, when passing through Detroit, to stop and visit with him. Mr. Hill's territory has also been extended to cover everything west of Cleveland, Ohio. This new move during the present uncertainty and slack times in the automobile and allied industries on the part of the Anti-Friction Company speaks well for the optimism and faith of the management of the company in a revival of the present condition. With apologies to a good old poet, we might say: "Ball-bearing companies come and ball-bearing companies go, but W. S. Rogers and the Anti-Friction Company go on forever."

The Edwards Manufacturing Company, 324 East Fifth street, Cincinnati, Ohio, sends us the following description of its "electro-portable" pump: "The principal market for this pump has been among owners of boats, barges, etc., who have found it a decided success. The pump is simply attached to an electric light socket, after which a turn of the switch starts the water coming at a rapid rate—sometimes 500 gallons per minute. Another feature is that it works perfectly whether on an alternating or direct current. It is an unusually light pump and easy to set up. The motor and all on this small-size pump weighs only 118 pounds. The absence of valves is another notable feature. The pump can't freeze, as it automatically drains itself. The material is genuine brass, and it is of ball-bearing construction—self-lubricated. The motor sustains its own weight, being attached to the exhaust tubing. The fact that there is no bearing on the shaft means no wear on the parts. Among the prominent concerns which recently have purchased these pumps is the Louisville & Cincinnati Packet Company."

ROPE KNOWLEDGE.—The terms used by the makers of rope and also by those who sell this commodity are not always understood, especially in the case of those who have had little or no experience in handling rope. In a recent number of *Plymouth Products* we find these technical terms explained as follows: Yarn or thread: A number of fibers twisted together compactly. The twist can be either right or left-hand, as the goods require. Strand: Two or more yarns twisted together in the opposite direction to the twist in the yarns. Common-laid rope: Three or more strands twisted together in the opposite direction to the twist in the strands. Hawser-laid or cable-laid rope: Three—sometimes four—common-laid, three-stamped ropes twisted together in the opposite direction to the twist in the hopes. Lay: The degree of twist in a common-laid or hawser-laid rope, as shown by the number of turns per foot. Lays commonly used by us are regular, medium soft, soft, extra soft, medium hard, hard and extra hard. Often expressed as hard-laid, soft-laid, etc. Right-laid rope: Rope in which the strands are twisted together clockwise; *i. e.*, in the same direction as the movement of a clock's hands. Left-laid rope: Rope in which the strands are twisted together anti-clockwise. A hawser-laid rope is almost always constructed of right-laid ropes, making the hawser-laid rope itself left-laid. Hawser: A large common-laid rope used for towing. This should not be confused with hawser-laid rope described above. Coil: Standard length, unless descriptions designate otherwise, 200 fathoms or 1,200 feet. Half-coil: Standard length, unless descriptions designate otherwise, 100 fathoms or 600 feet. Yardage: Length per pound.

RECENT INSTALLATIONS by the Brunswick Refrigerating Company, New Brunswick, N. J., which builds refrigerating and ice-making plants for steamships as well as for land installations, include the following: A 4-ton plant on the steamship *Berkshire* of the Hudson Navigation Company, used for refrigerating work; a 2-ton plant for refrigerating work on the steamship *Buenaventura* of the Isthmian Steamship Company, of New York City. The Government Coast Survey steamer *Bache* was recently equipped with a 1-ton Brunswick refrigerating plant. Shortly after this the Isthmian Steamship Company placed a second orde rwith them for equipping their steamship *Santa Rosalia* with a 2-ton plant. Later an order was received from an exporting firm in New York City for a small ice-making apparatus for the *Empressa de Vapores F. Perez Rosa*, a river steamer hailing from Puerto Colombia, Republic of Colombia. A repeat order, by the way. A. H. Bull & Company have placed an order recently with the Brunspany placed a second order with them for equipping their steamer of their line to be equipped with a Brunswick plant. Repeat orders such as this prove the value of the Brunswick plant to steam ship owners. Through the Fore River Shipbuilding Company, of Quincy, Mass., the steamers *Atlantic* and *Pacific*, of the Emery Steamship Company of Boston, have each been equipped with a 1-ton Brunswick refrigerating plant. The New York & Cuba Mail Steamship Company placed an order with the Brunswick Company for equipping the steamship *Antilla*, the first of their freight steamers to be equipped with refrigerating plants, with a 2-ton plant for refrigerating and ice-making work. The plant was installed in part on one trip, and leaving the refrigerators undisturbed the installation was completed upon the return of the steamer to New York, after its trip South. The Texas Company ordered a 2-ton plant for their steamship *Texas*, the first of their steamers to be equipped with a refrigerating plant, and this was installed while the steamer was undergoing repairs in New York. The Brunswick Company is able to furnish and install this marine apparatus in a very few days and at only a day's notice. They will be glad to send you a list of steamships equipped with their plants on request. Just drop a line requesting this list to the Brunswick Refrigerating Company, 130 Jersey avenue, New Brunswick, N. J.

BUSINESS NOTES

GREAT BRITAIN

CASTOLIN AUTO-CHEMICAL WELDING.—We are informed by The Casolin Company, of Great Britain, Clock House, Arundel street, Strand, W. C., that, at the commencement of those two great enterprises, the Berne-Loetschberg-Simplon and the Mont D'Or tunnels a standard case of the "Castolin' autochemical welding process was installed at each end, and during the whole of the boring was used for the purpose of repairing all broken machinery—in cast iron iron, wrought iron and steel.

Diesel Engine Information

The Publisher of International Marine Engineering has made arrangements with the well-known London Diesel engine expert, Mr. J. Rendell Wilson, to give *free* advice to bona fide Ship-owners in connection with the installation of heavy oil engines.

Mr. Wilson, who is a frequent contributor to this journal will be pleased to advise as to what type and make of engine is suitable for any particular vessel, provided dimensions of the vessel, power and speed required, also dimensions of the engine-room, and a drawing of the accommodation arrangements are enclosed.

Advice will also be given regarding proposed conversions from steam, or gasoline, to heavy oil power. In such cases the present running costs should be added, and then Mr. Wilson will point out the saving that can be effected.

Correspondence should be addressed to MR. WILSON, care of International Marine Engineering, either at the New York or London Office.

HELP AND SITUATION AND FOR SALE ADVERTISEMENTS

No advertisements accepted unless cash accompanies the order.

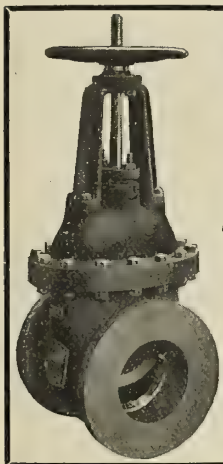
Advertisements will be inserted under this heading at the rate of 4 cents (2 pence) per word for the first insertion. For each subsequent consecutive insertion the charge will be 1 cent (½ penny) per word. But no advertisement will be inserted for less than 75 cents (3 shillings). Replies can be sent to our care if desired, and they will be forwarded without additional charge.

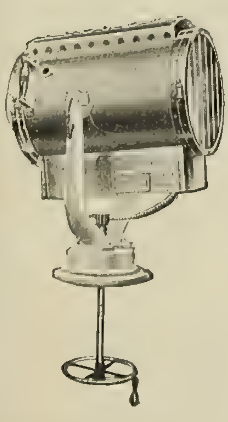
Ship Draughtsman Wanted—First-class detailed draughtsman. Must be quick and accurate. Apply *Box No.* 81, care INTERNATIONAL MARINE ENGINEERING.

Scotch Boiler for Sale—11 feet by 11 feet. Suitable for tugboat. Apply *Room* 2113, *No.* 90 *West Street, New York.*

Engineers desiring valuable data on boiler operation should write for our new booklet—it's free if you tell us where you saw our ad. The Federal Graphite Mills, Cleveland, Ohio.

Wanted—Experienced marine draftsmen on details and installation of marine engines, propelling machinery, etc. Address *Box* 65, care of INTERNATIONAL MARINE ENGINEERING.





MARINE SOCIETIES.

AMERICA.

AMERICAN SOCIETY OF NAVAL ENGINEERS
Navy Department, Washington, D. C.

SOCIETY OF NAVAL ARCHITECTS AND MARINE ENGINEERS
29 West 39th Street, New York.

NATIONAL ASSOCIATION OF ENGINE AND BOAT MANUFACTURERS
29 West 39th Street, New York City.

UNITED STATES NAVAL INSTITUTE
Naval Academy, Annapolis, Md.

AMERICAN ASSOCIATION OF MASTERS, MATES AND PILOTS
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Grand Auditors—Richard McLaren, Owen Sound; L. B. Cronk, Windsor, Ont.

GREAT BRITAIN.

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5 Adelphi Terrace, London, W. C.

INSTITUTION OF ENGINEERS AND SHIPBUILDERS IN SCOTLAND
39 Elmbank Crescent, Glasgow.

NORTHEAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS
Bolbec Hall, Westgate Road, Newcastle-on-Tyne.

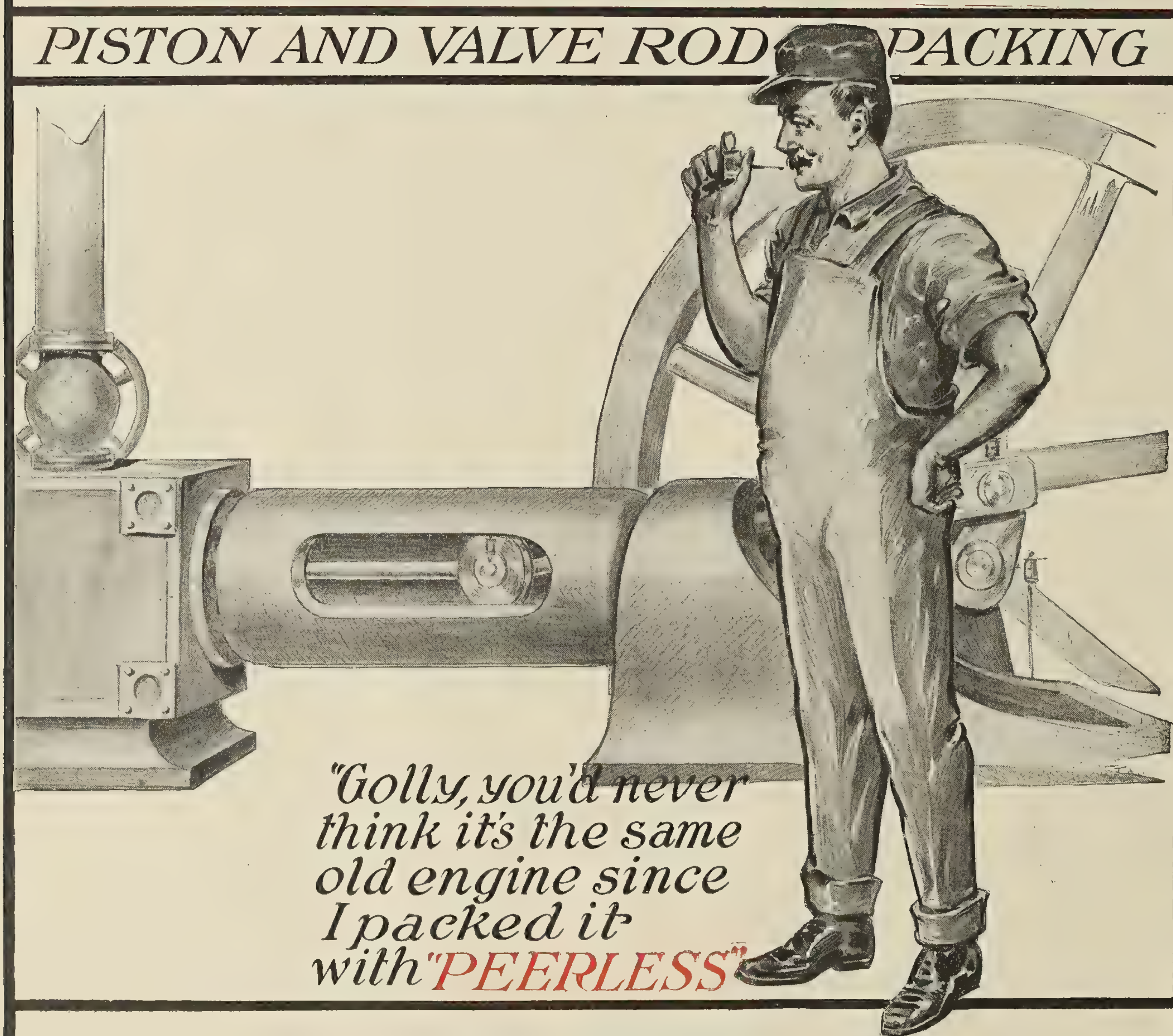
INSTITUTE OF MARINE ENGINEERS, INCORP.
58 Romford Road, Stratford, London, E.

GERMANY.

SCHIFFBAUTECHNISCHE GESELLSCHAFT
Technische Hochschule, Charlottenburg.

PEERLESS PACKING

PISTON AND VALVE ROD PACKING



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16 WARREN ST., NEW YORK.

FOR SALE EVERYWHERE

Christmas

We rejoice with you at this season of the year in the good things the past has brought, and hope that the new year may be one of peace and gladness. That your joys may multiply as your years increase is our wish when we say

"Merry Christmas"

"Watch the Thermometer"

Eckliff Automatic Boiler Circulators installed in Scotch Marine Boilers make them trouble-proof.

Raising 160 pounds steam in forty-five minutes—***from cold water***—is the record of a recent Eckliff installation. And there are many other Eckliffs furnishing like testimony. These records of proven achievement should mean much to you—they ***must.***

Surely you'll be glad to have done forever with scale troubles, pitting, grooving, furrowing, furnace cracking, breaking staybolts and leaky girth seams. Surely you'll welcome the means for greatly increasing your boilers' efficiency and adding many years to their life.

Sit right down now and make the first move toward highest boiler efficiency.

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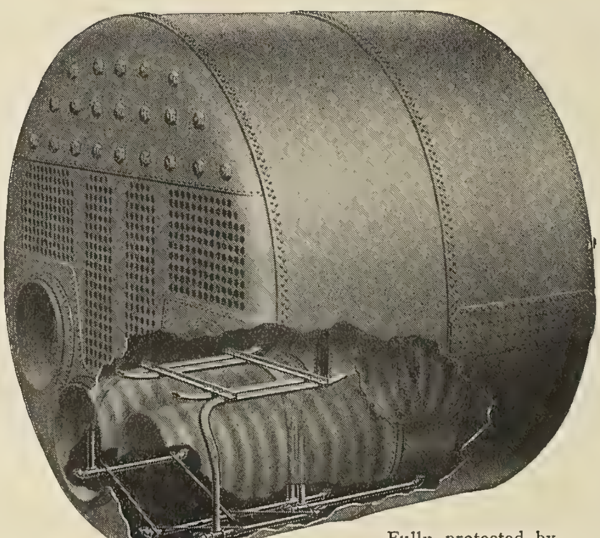

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Create and Maintain Perfect Circulation

J-M Boiler Preservative
Versus
Boiler Scale


Boiler Scale

When J-M Boiler Preservative is fed into a boiler it is attracted by the heated steel surfaces.

When water is heated, the scale-forming elements it contains are attracted by the heated steel surfaces.

Two things cannot occupy the same space at the same time. J-M Boiler Preservative is attracted by the heated surfaces of a boiler *to a much greater degree* than scale or scale-forming elements. It gets *underneath* the scale, next to the boiler and the scale is thus loosened, drops off, and can be blown or washed out.

It keeps the heating surface covered with a thin *heat-conducting* film that will not permit scale formation.

J-M Boiler Preservative is a natural remedy, made from a vegetable and contains salts extracted from the soil, so cannot injure a boiler, fittings or packings.

It will work in any locality at any season of the year. It will remove and prevent scale at a lower cost than any other method that may be employed.

We will send you one drum of J-M Boiler Preservative for a 60 days' free trial. Unless results satisfactory to you are produced, no charge will be made for quantity used in making test.

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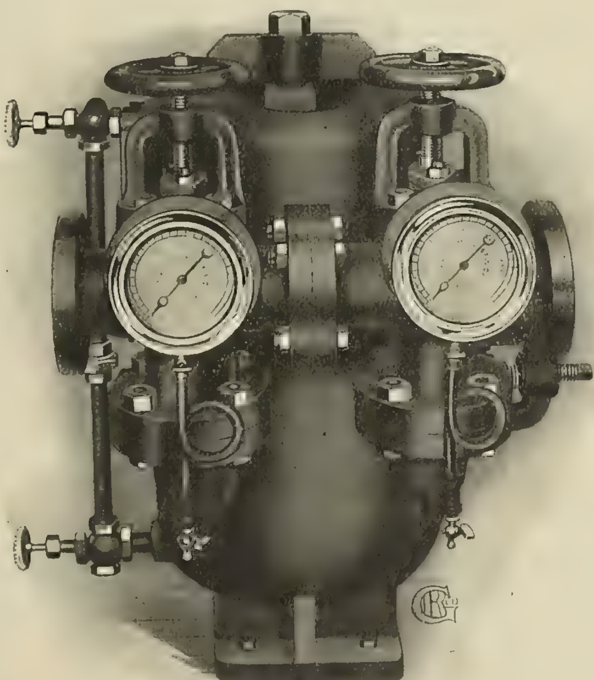

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Accessible. All filters have to be cleaned. The Reilly Cartridges can be removed through a convenient handhole, washed and replaced without breaking pipe connections. The boiler feed need never be interrupted for we provide a by-pass. Two blow-offs clear the filter of scum and sediment.

Write for Bulletin 607

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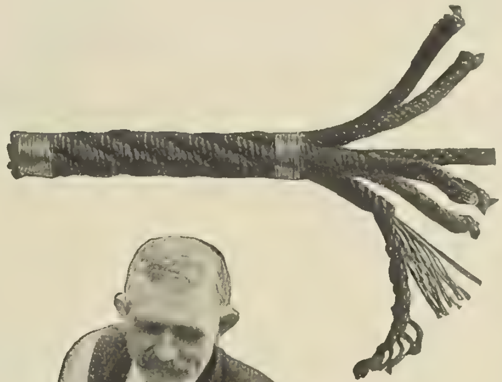

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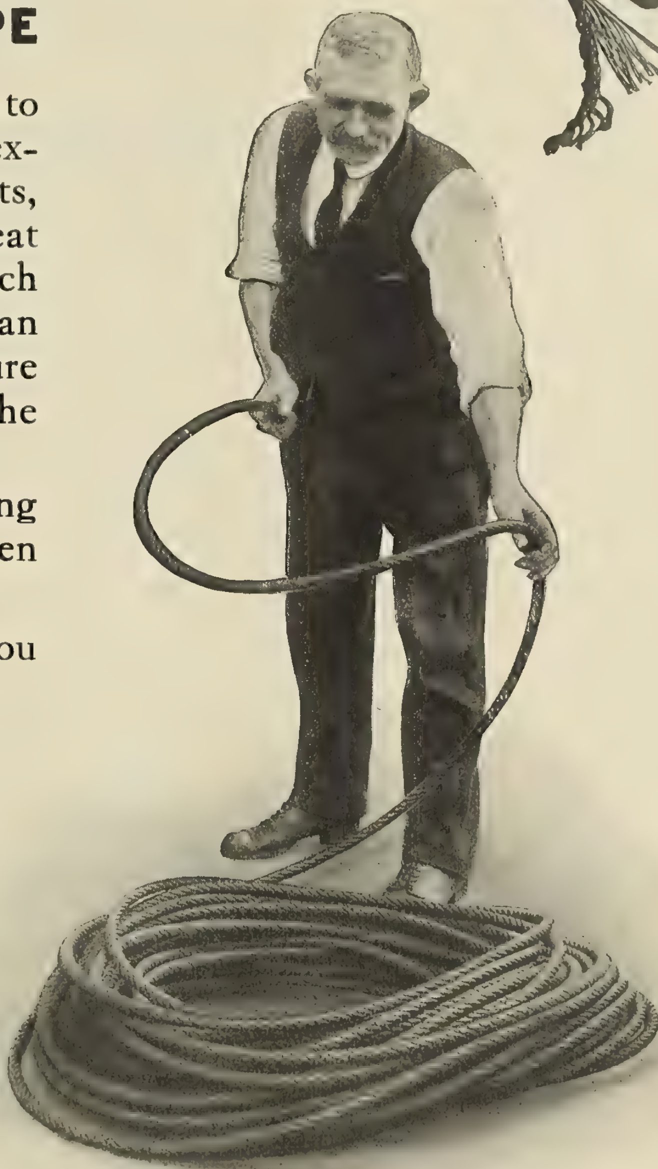

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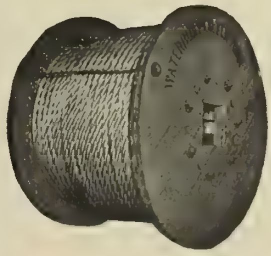

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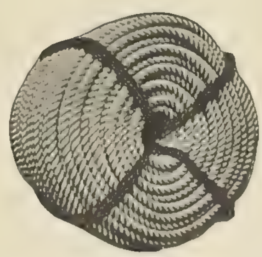

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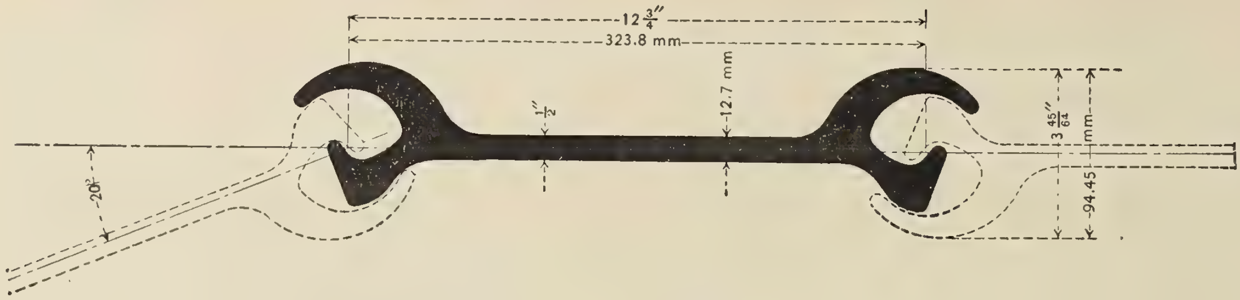

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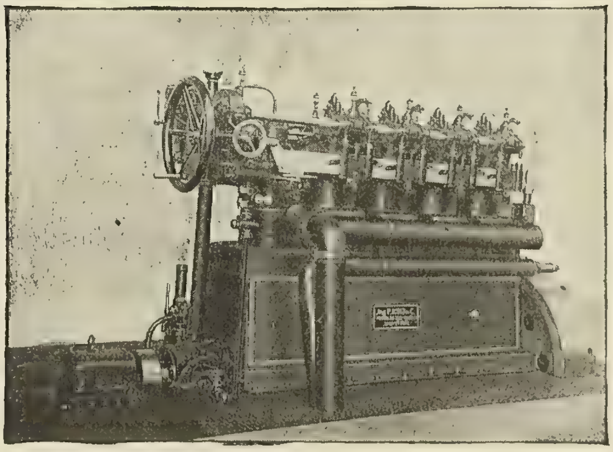
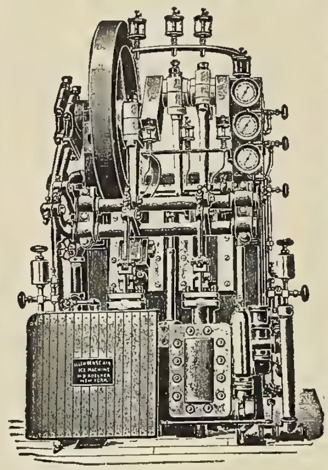
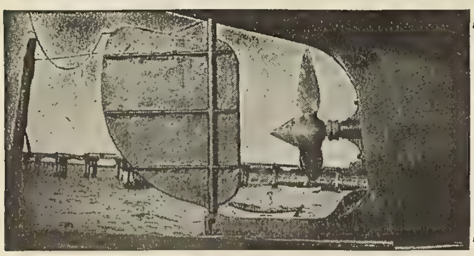
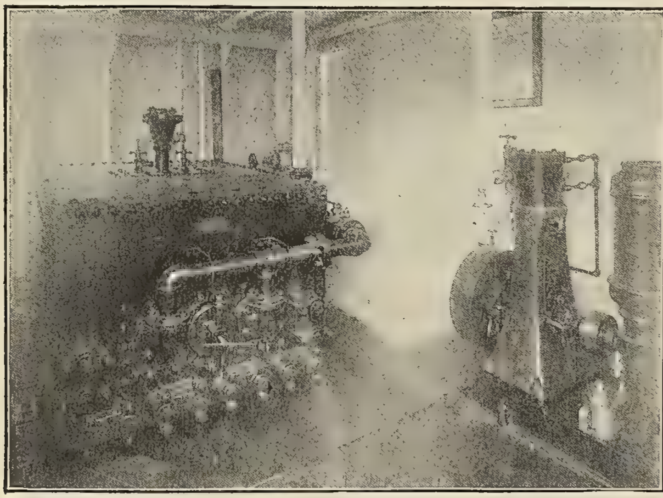
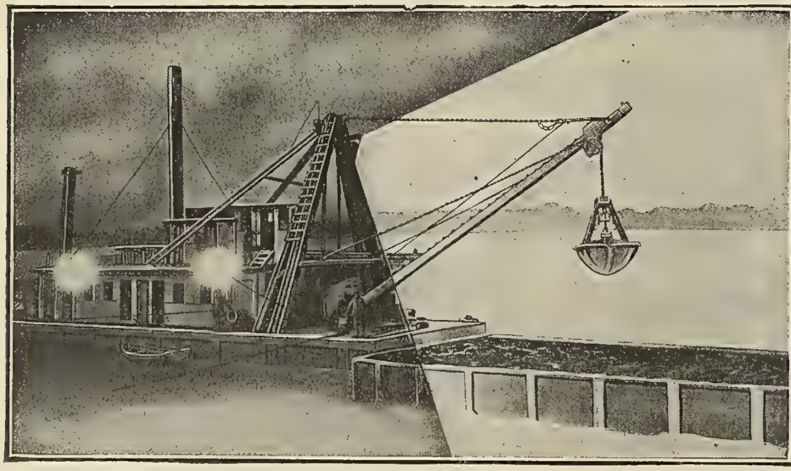


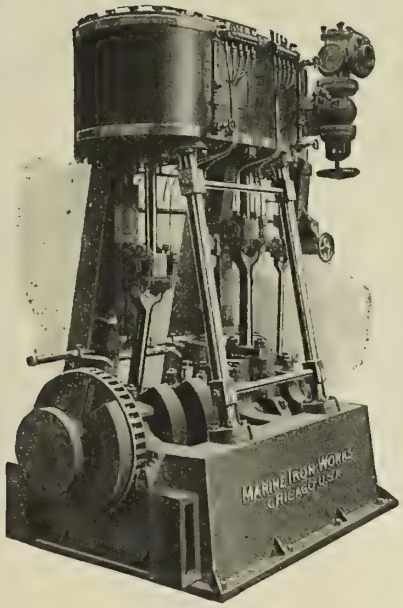








Engine Operating Centrifugal Pump on Dredge in Cuba



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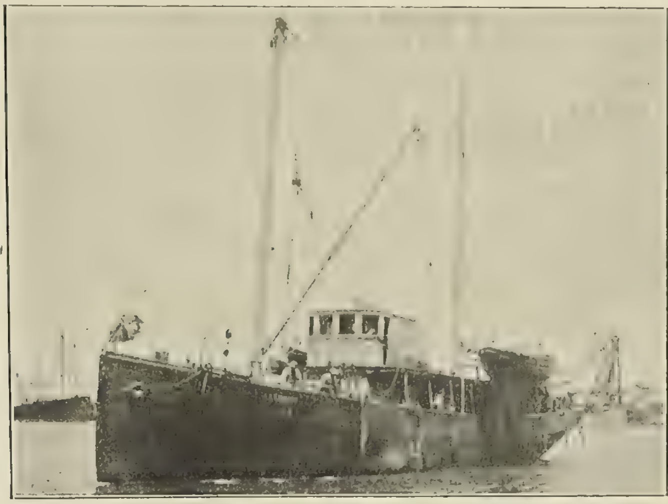

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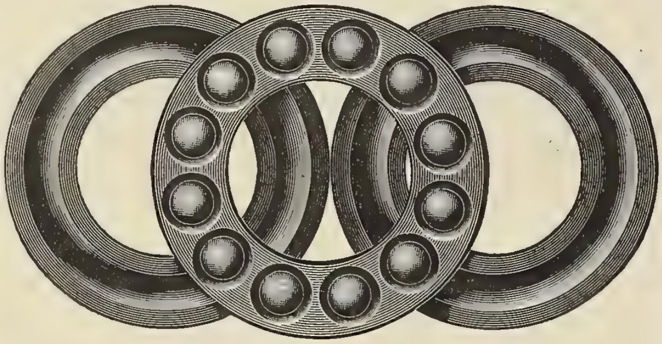

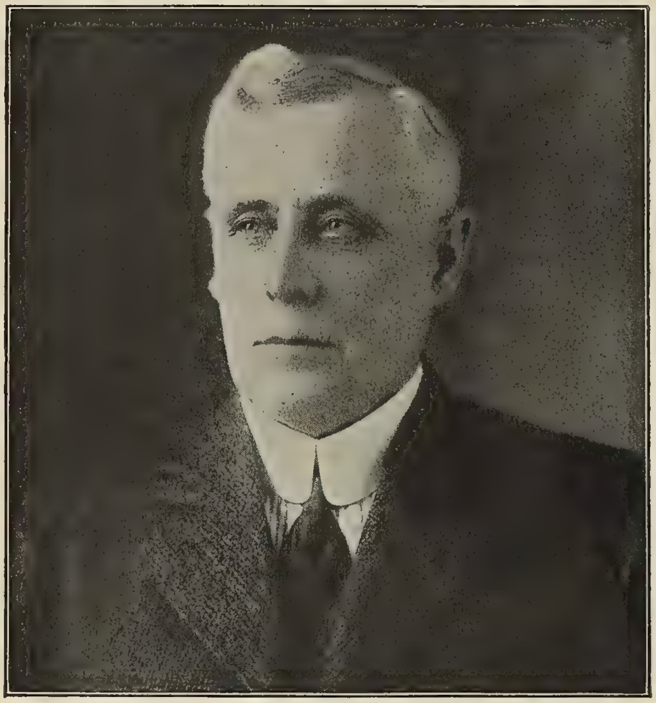

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Durable Wire Rope Co., Boston, Mass.
Griscom-Russell Co., New York.
Plymouth Cordage Co., North Plymouth, Mass.
Waterbury Co., New York.
Whitlock Cordage Co., New York.

CORK CEMENT, FENDERS, JACKETS, RINGS.
Ferdinand, L. W., & Co., Boston, Mass.

CORRUGATED FURNACES.
Continental Iron Works, Brooklyn, N. Y.

COTTON DUCK—See DUCK.

COTTON RUBBER-LINED HOSE—See HOSE.

COUNTERS—See REVOLUTION COUNTERS.

COVERING, STEAM—See NON-CONDUCTING COVERING.

CRANES.
American Engineering Co., Philadelphia, Pa.
Brown Hoisting Machinery Co., Cleveland, Ohio.
Niles-Bement-Pond Co., New York.
Welin Marine Equipment Co., Long Island City, N. Y.

CRANK SHAFTS—See FORGINGS.

CUTTERS.
Morse Twist Drill & Machine Co., New Bedford, Mass.

CYLINDER BORING BARS.
Niles-Bement-Pond Co., New York.

CYLINDER RELIEF VALVES—See VALVES.

CYLINDERS FOR COMPRESSED AIR, GAS, ETC.
National Tube Co., Pittsburg, Pa.

DAMPER REGULATORS.
Diamond Power Specialty Co., Detroit, Mich.

DAVITS.
Welin Marine Equipment Co., Long Island City, N. Y.

DECK HOISTS—See HOISTING ENGINES.

DECK PLATES.
Sands, A. B., & Son Co., New York.

DECK PUMPS—See PUMPS.

DIAPHRAGM PUMPS—See PUMPS.
Hyde Windlass Co., Bath, Maine.

DIES.
Morse Twist Drill & Machine Co., New Bedford, Mass.

DIRECT-CONNECTED SETS—See ELECTRICAL PLANTS.

DIRECTION AND REVOLUTION INDICATORS.
McNab Co., The, Bridgeport, Conn.

DISENGAGING GEARS.
Welin Marine Equipment Co., Long Island City, N. Y.

DISTILLERS—See EVAPORATORS.

DIVING APPARATUS.
Morse, Andrew J., & Son, Inc., Boston, Mass.

DRAFT, MECHANICAL—See MECHANICAL DRAFT.

DRAFT GAUGES.
McNab Co., The, Bridgeport, Conn.

DRAFTING INSTRUMENTS.
Starrett, L. S., Co., Athol, Mass.

DRAIN VALVES—See VALVES.

DREDGING MACHINERY.
Alberger Pump and Condenser Co., New York.
American Engineering Co., Philadelphia, Pa.

DRILLING MACHINES, VERTICAL, HORIZONTAL AND RADIAL.
Niles-Bement-Pond Co., New York.

DRILLS.
Morse Twist Drill & Machine Co., New Bedford, Mass.

DRILLS, ELECTRIC—See ELECTRIC DRILLS.

DRILLS, PNEUMATIC—See PNEUMATIC TOOLS—Also AIR DRILLS.

DRILLS, PORTABLE—See PORTABLE DRILLS.

DROP FORGINGS—EYE BOLTS, HOOKS, ROPE SOCKETS, WRENCHES, ETC.
Williams & Co., J. H., Brooklyn, N. Y.

DROP HAMMERS.
Niles-Bement-Pond Co., New York.

DRY DOCKS AND MARINE RAILWAYS.
Krajewski-Pesant Corporation, Havana, Cuba.
Merrill-Stevens Co., Jacksonville Fla.
Newport News Shipbuilding & Dry Dock Co., Newport News, Va
Tietjen & Lang Dry Dock Co., Hoboken, N. J.

DRY DOCKS—MARINE RAILWAY—MANUFACTURER.
Crandall Engineering Co., The, East Boston, Mass.

DRYING APPARATUS.
American Blower Co., Detroit, Mich.
Sturtevant Co., B. F., Hyde Park, Mass.

DUCK.
Boyle, John, & Co., Inc., New York.

DYNAMOS—See ELECTRIC PLANTS; also STEAM TURBINE DYNAMOS.

ECONOMIZERS, FUEL—See FUEL ECONOMIZERS.

EJECTORS.
Lunkenheimer Co., Cincinnati, Ohio.
Schutte & Körting Co., Philadelphia, Pa.

ELECTRIC DRILLS.
General Electric Co., Schenectady, N. Y.
Independent Pneumatic Tool Co., Chicago and New York.
Johns-Manville, H. W., Co., New York.

ELECTRIC HEATERS.
General Electric Co., Schenectady, N. Y.
Simplex Electric Heating Co., Cambridgeport, Mass.

ELECTRIC HOISTS.
American Engineering Co., Philadelphia, Pa.
Brown Hoisting Machinery Co., Cleveland, Ohio.
General Electric Co., Schenectady, N. Y.
Hyde Windlass Co., Bath, Maine.
Lidgerwood Mfg. Co., New York.
Niles-Bement-Pond Co., New York.

ELECTRIC LIGHTS.
General Electric Co., Schenectady, N. Y.

ELECTRIC PLANTS.
Gas Engine & Power Co., and Chas. L. Seabury & Co., Consol., Morris Heights, N. Y.
General Electric Co., Schenectady, N. Y.
Sturtevant Co., B. F., Hyde Park, Mass.
Terry Steam Turbine Co., Hartford, Conn.

ELECTRICAL FITTINGS AND SUPPLIES—Also see ELECTRIC PLANTS.
General Electric Co., Schenectady, N. Y.
Griscom-Russell Co., New York.
Johns-Manville, H. W., Co., New York.

ELECTRICAL INSTRUMENTS.
General Electric Co., Schenectady, N. Y.
Weston Electrical Instrument Co., Waverly Park, Newark, N. J.

ELEVATORS, FREIGHT—See FREIGHT ELEVATORS, also INCLINED ELEVATORS.

ENGINE PACKING—See PACKING.

ENGINE-ROOM SUPPLIES—See STEAM SPECIALTIES.

ENGINEERS, CONSULTING AND CONTRACTORS.
American Engineering Co., Philadelphia, Pa.
Donnelly, W. T., New York.
Griscom-Russell Co., New York.
Hough, Edward S., San Francisco, Cal.
Whitaker, Morris M., Nyack, N. Y.

ENGINES FOR AUXILIARIES.
Alberger Pump and Condenser Co., New York.
American Blower Co., Detroit, Mich.
American Engineering Co., Philadelphia, Pa.
De Laval Steam Turbine Co., Trenton, N. J.
Hyde Windlass Co., Bath, Maine.
Kerr Turbine Co., Wellsville, N. Y.
Marine Iron Works, Chicago, Ill.
Sturtevant Co., B. F., Hyde Park, Mass.
Terry Steam Turbine Co., Hartford, Conn.

ENGINES, GASOLINE—See GASOLINE ENGINES.

ENGINES, HOISTING—See HOISTING ENGINES.

ENGINES, KEROSENE—See KEROSENE ENGINES.

ENGINES, OIL—See also DIESEL ENGINES.
Mietz, A., New York.

ENGINES—PROPELLING.
Bath Iron Works, Bath, Maine.
Gas Engine & Power Co., & Chas. L. Seabury & Co., Consol., Morris Heights, New York.
Kingsford Foundry & Machine Works, Oswego N. Y.
Marine Iron Works, Chicago, Ill.
Mietz, A., New York.
Parsons Marine Steam Turbine Co., New York.
Sheriffs Mfg. Co., Milwaukee, Wis.
Trout, H. G., Co., Buffalo, N. Y.
Ward, Chas., Engineering Works, Charleston, W. Va.

ENGINE-ROOM CLOCKS—See CLOCKS.

ESCALATORS.
Otis Elevator Co., New York.

EVAPORATORS.
Alberger Pump and Condenser Co., New York.
American Engineering Co., Philadelphia, Pa.
Davidson, M. T., Co., New York.
Griscom-Russell Co., New York.
Schutte & Körting Co., Philadelphia, Pa.

EXCESS PUMP GOVERNORS—See PUMP GOVERNORS.

EXHAUST FANS—See BLOWERS.

EXHAUST HEADS.
Sturtevant Co., B. F., Hyde Park, Mass.

EXPANDERS—See BOILER FLUE AND TUBE EXPANDERS.

EXPANSION JOINTS.
Alberger Pump and Condenser Co., New York.
Griscom-Russell Co., New York.
Lunkenheimer Co., Cincinnati, Ohio.
National Tube Co., Pittsburg, Pa.

FANS—See BLOWERS.

FEED CHECK VALVES—See VALVES.

FEED-WATER HEATERS AND PURIFIERS.
Alberger Pump and Condenser Co., New York.
American Engineering Co., Philadelphia, Pa.
Griscom-Russell Co., New York.
Schutte & Körting Co., Philadelphia, Pa.

FEED-WATER REGULATORS.
Alberger Pump and Condenser Co., New York.
Jerguson Gage & Valve Co., Boston, Mass.

FERRY BOAT LAMPS—See LAMPS.

FILES.
Nicholson File Co., Providence, R. I.

FILTERS.
Griscom-Russell Co., New York.
Schutte & Körting Co., Philadelphia, Pa.

FIRE DEPARTMENT SUPPLIES.
Fumigating & Fire Extinguishing Co. of America, New York.
Hayward, S. F., & Co., New York.
Morse, Andrew J., & Son, Inc., Boston, Mass.

FIRE EXTINGUISHERS.
Fumigating & Fire Extinguishing Co. of America, New York.
Hayward, S. F., & Co., New York.
Morse, Andrew J., & Son, Inc., Boston, Mass.

FIRE HOSE—See HOSE.

FIREPROOF CONSTRUCTION.
Johns-Manville, H. W., Co., New York.
Keyes Products Co., New York.

FIREPROOF LUMBER—See LUMBER, FIREPROOF.

FIRE PUMPS—See PUMPS.

FLANGES.
Dart, E. M., Mfg. Co., Providence, R. I.
Lunkenheimer Co., Cincinnati, Ohio.
National Tube Co., Pittsburg, Pa.
Williams Valve Co., D. T., Cincinnati, Ohio.

FLANGING PRESSES.
Niles-Bement-Pond Co., New York.

FLEXIBLE SHAFTING.
Stow Mfg. Co., Binghamton, N. Y.

FLOATING DRY DOCKS—See DRY DOCKS.

FLUE CLEANERS—See BOILER FLUE CLEANERS.

FLUE CUTTERS—See BOILER FLUE AND TUBE CUTTERS.

FORCED DRAFT—See also BLOWERS.
American Blower Co., Detroit, Mich.
De Laval Steam Turbine Co., Trenton, N. J.
General Electric Co., Schenectady, N. Y.
Sturtevant Co., B. F., Hyde Park, Mass.

FORGES.
Sturtevant Co., B. F., Hyde Park, Mass.

FORGINGS, BRONZE—See also DROP FORGINGS.
Hyde Windlass Co., Bath, Me.

FREIGHT ELEVATORS FOR DOCKS AND WHARVES.
Otis Elevator Co., New York.

FREIGHT-HANDLING EQUIPMENT.
Brown Hoisting Machinery Co., Cleveland, Ohio.
Link-Belt Co., Chicago, Ill.
Otis Elevator Co., New York.

FRIGIDOMETERS.
McNab Co., The, Bridgeport, Conn.

FROSTPROOF COVERINGS.
Ferdinand, L. W., & Co., Boston, Mass.

FUEL ECONOMIZERS.
Griscom-Russell Co., New York.
Sturtevant Co., B. F., Hyde Park, Mass.

FUEL OIL BURNERS.
Lalor Fuel System Co., Philadelphia, Pa.
Schutte & Körting Co., Philadelphia, Pa.

FURNACES—Also see CORRUGATED FURNACES.
Continental Iron Works, New York.

FUSIBLE PLUGS.
Griscom-Russell Co., New York.
Lunkenheimer Co., Cincinnati, Ohio.
Williams Valve Co., D. T., Cincinnati, Ohio.

GALLEYS—See RANGES.

GAS BLOWERS AND EXHAUSTERS.
American Blower Co., Detroit, Mich.
Schutte & Körting Co., Philadelphia, Pa.
Sturtevant Co., B. F., Hyde Park, Mass.

GASKETS—Also see PACKING.
Griscom-Russell Co., New York.
Johns-Manville, H. W., Co., New York.
Katzenstein & Co., L., New York.
New York Belting & Packing Co., New York.
Peerless Rubber Mfg. Co., New York.
Smooth-On Mfg. Co., Jersey City, N. J.

GASOLINE ENGINES—Also see LAUNCHES AND YACHTS. KEROSENE ENGINES; OIL ENGINES; DIESEL ENGINES.
Bridgeport Motor Co., Bridgeport, Conn.
Gas Engine & Power Co., & Chas. L. Seabury & Co., Consol., Morris Heights, New York.
Mietz, A., New York.
Standard Motor Construction Co., Jersey City, N. J.

GAS ENGINE SPECIALTIES.
Lunkenheimer Co., Cincinnati, Ohio.
Nelson Valve Co., Philadelphia, Pa.
Powell, Wm., Co., Cincinnati, Ohio.
Star Brass Mfg. Co., Boston, Mass.
Williams Valve Co., D. T., Cincinnati, Ohio.

GAS PRODUCERS—See MARINE GAS PRODUCERS.

GATE VALVES—See VALVES.

GAUGE COCKS.
Jerguson Gage & Valve Co., Boston, Mass.
Lunkenheimer Co., Cincinnati, Ohio.
National Tube Co., Pittsburg, Pa.
Nelson Valve Co., Philadelphia, Pa.
Powell, Wm., Co., Cincinnati, Ohio.
Star Brass Mfg. Co., Boston, Mass.
Williams Valve Co., D. T., Cincinnati, Ohio.

GAUGES—See STEAM GAUGES; also WATER GAUGES.

GAUGE GLASSES.
Jerguson Gage & Valve Co., Boston, Mass.
Lunkenheimer Co., Cincinnati, Ohio.
Williams Valve Co., D. T., Cincinnati, Ohio.

GENERATORS—See ELECTRIC PLANTS.

GLOBE VALVES—See VALVES.

GLUE—LINOLEUM, MARINE, SHIP, YACHT, WATERPROOF.
Ferdinand, L. W., & Co., Boston, Mass.

GONGS.
National Tube Co., Pittsburg, Pa.

GOVERNORS—See PUMP GOVERNORS.

GRABS—See DREDGING MACHINES.

GRAPHITE.
Dixon, Jos., Crucible Co., Jersey City, N. J.

GRATE BARS.
Griscom-Russell Co., New York.

GREASE—See LUBRICANTS.

GREASE CUPS—See LUBRICATORS.
Albany Lubricating Co., New York.
Cook's Sons, Adam, New York.
Griscom-Russell Co., New York.
Lunkenheimer Co., Cincinnati, Ohio.

GREASE EXTRACTORS.
Griscom-Russell Co., New York.

GYPSEYS.
American Engineering Co., Philadelphia, Pa.
Hyde Windlass Co., Bath, Maine.

HAMMERS, PNEUMATIC—See PNEUMATIC TOOLS.

HARDWARE—See MARINE HARDWARE; also CHANDLERY STORES.

HARDWOOD—See LUMBER.

HAWSERS—See WIRE ROPE.

HEATERS—BATH, LAVATORY, SHOWER.
Alberger Pump and Condenser Co., New York.
Sands, A. B., & Son Co., New York.
Schutte & Körting Co., Philadelphia, Pa.

HEATING AND VENTILATING APPARATUS.
American Blower Co., Detroit, Mich.
Schutte & Körting Co., Philadelphia, Pa.
Sturtevant Co., B. F., Hyde Park, Mass.

HELMETS, SMOKE AND AMMONIA.
Hayward, S. F., & Co., New York.

HEMP—See TWINE.

HOISTING ENGINES.
American Engineering Co., Philadelphia, Pa.
Hyde Windlass Co., Bath, Maine.
Lidgerwood Mfg. Co., New York.

HOISTS, CHAIN—See CHAIN HOISTS.

HOISTS, ELECTRIC—See ELECTRIC HOISTS.

HOSE—See AIR HOSE.
Eureka Fire Hose Mfg. Co., New York.
Hayward, S. F., & Co., New York.
Independent Pneumatic Tool Co., Chicago and New York.
New York Belting & Packing Co., New York.

HOSE COUPLING.
Eureka Fire Hose Co., New York.
Hayward, S. F., & Co., New York.
Independent Pneumatic Tool Co., Chicago and New York.
National Tube Co., Pittsburg, Pa.

HOSE NOZZLES.
Hayward, S. F., & Co., New York.
Morse, Andrew J., Son, Inc., Boston, Mass.

HOSE REELS AND RACKS.
Hayward, S. F., & Co., New York.

HUMIDIFIERS.
Griscom-Russell Co., New York.

HYDRAULIC FITTINGS.
Lunkenheimer Co., Cincinnati, Ohio.
National Tube Co., Pittsburg, Pa.
Powell, Wm., Co., Cincinnati, Ohio.
Schutte & Körting Co., Philadelphia, Pa.

HYDRAULIC MACHINERY—RIVETERS, PUNCHES, SHEARS.
Niles-Bement-Pond Co., New York.

ICE DETECTORS.
McNab Co., The, Bridgeport, Conn.

ICE MACHINES—See REFRIGERATING PLANTS.

INCLINED ELEVATORS FOR DOCKS AND WHARVES.
Otis Elevator Co., New York.

INDICATOR CONNECTIONS.
Lunkenheimer Co., Cincinnati, Ohio.

INDICATORS—STEAM AND GAS ENGINE—Also see DIRECTION AND REVOLUTION INDICATORS.
Lunkenheimer Co., Cincinnati, Ohio.
Powell Co., The, Wm., Cincinnati, Ohio.
Star Brass Mfg. Co., Boston, Mass.

INDUCED DRAFT.
American Blower Co., Detroit, Mich.
Sturtevant Co., B. F., Hyde Park, Mass.

INJECTORS.
Lunkenheimer Co., Cincinnati, Ohio.
Powell Co., The, Wm., Cincinnati, Ohio.
Schutte & Körting Co., Philadelphia, Pa.

INSURANCE—MARINE AND FIRE.
Hutchinson, Rivinus & Co., New York and Philadelphia.

INTERLOCKING RUBBER TILING.
Griscom-Russell Co., New York.
New York Belting & Packing Co., New York.

IRON CEMENT.
Smooth-On Mfg. Co., Jersey City, N. J.

JACKS—PNEUMATIC.
Independent Pneumatic Tool Co., Chicago and New York.

JOURNAL BEARINGS—See THRUST BEARINGS.

JUTE.
Columbian Rope Co., Auburn and New York.

KEROSENE ENGINES—See also OIL ENGINES AND DIESEL ENGINES.
Gas Engine & Power Co., & Chas. L. Seabury & Co., Consol., Morris Heights, New York.
Mietz, A., New York.

LATHES, CRANK SHAFT.
Niles-Bement-Pond Co., New York.

LAMPS, SIGNALS, AND FIXTURES.
Carlisle & Finch Co., Cincinnati, Ohio.
General Electric Co., Schenectady, N. Y.
Johns-Manville, H. W., Co., New York.

LATHES, ENGINE.
Niles-Bement-Pond Co., New York.

LATHES, TURRET.
Niles-Bement-Pond Co., New York.

LAUNCHES AND YACHTS—See also SHIPBUILDERS AND DRY DOCK COMPANIES.
Bridgeport Motor Co., Bridgeport, Conn.
Gas Engine & Power Co., & Chas. L. Seabury & Co., Consol., Morris Heights, New York.
Marine Iron Works, Chicago, Ill.
Standard Motor Construction Co., Jersey City, N. J.
Ward, Chas., Engineering Works, Charleston, W. Va.
Welin Marine Equipment Co., Long Island City, N. Y.

LAVATORIES—FOLDING, STATIONARY, STATEROOM.
Sands, A. B., & Son Co., New York.

LAVATORY AND BATH HEATERS.
Griscom-Russell Co., New York.
Schutte & Körting Co., Philadelphia, Pa.

LIFE BOATS AND RAFTS.
Welin Marine Equipment Co., Long Island City, N. Y.

LIFE GUNS.
Hayward, S. F., & Co., New York.

LIFE PRESERVERS.
Ferdinand, L. W., & Co., Boston, Mass.
Welin Marine Equipment Co., Long Island City, N. Y.

LIFE-SAVING DEVICES.
Hayward, S. F., & Co., New York.
Welin Marine Equipment Co., Long Island City, N. Y.

LIGHTS.
Milburn, Alex. C., Co., Baltimore, Md.

LIGHT BUOYS.
Milburn, Alex. C., Co., Baltimore, Md.

LIGHTHOUSE APPARATUS.
Milburn, Alex. C., Co., Baltimore, Md.

LINOLEUM CEMENT.
Ferdinand, L. W., & Co., Boston, Mass.

LIQUID GLUE, WATERPROOF.
Ferdinand, L. W., & Co., Boston, Mass.

LOG REGISTERS.
Nicholson Ship Log Co., Cleveland, Ohio.
Schuette Recording Compass Co., Manitowoc, Wis.
Welin Marine Equipment Co., Long Island City, N. Y.

LUBRICANTS.
Albany Lubricating Co., New York.
Cook's Sons, Adam, New York.
Dixon, Jos., Crucible Co., Jersey City, N. J.

LUBRICATING COMPOUND.
Albany Lubricating Co., New York.
Cook's Sons, Adam, New York.

LUBRICATORS.
Albany Lubricating Co., New York.
Cook's Sons, Adam, New York.
Griscom-Russell Co., New York.
Lunkenheimer Co., Cincinnati, Ohio.
Powell, Wm., Co., Cincinnati, Ohio.
Schutte & Körting Co., Philadelphia, Pa.
Williams Valve Co., D. T., Cincinnati, Ohio.

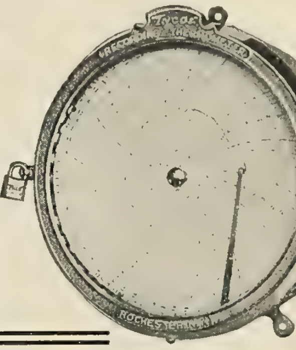
LUMBER.
Vrooman, S. B., Co., Philadelphia, Pa.

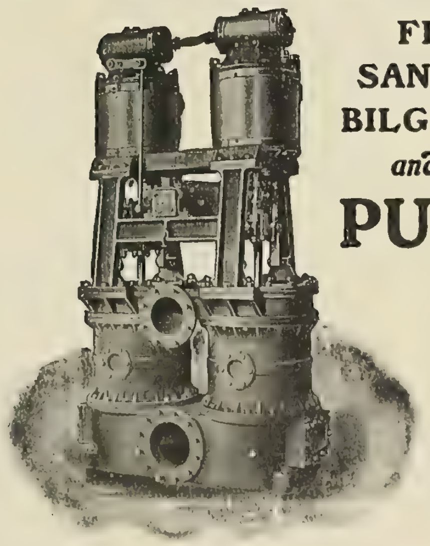
LUMBER—FIREPROOF.
Keyes Products Co., New York.

MACHINE TOOLS—See TOOLS, MACHINE.

MAHOGANY—See LUMBER.

MANGANESE BRONZE CASTINGS—Also see BRONZE.
Griscom-Russell Co., New York.
Hyde Windlass Co., Bath, Maine.
Lunkenheimer Co., Cincinnati, Ohio.
Phosphor-Bronze Smelting Co., Philadelphia, Pa.





MAGNESIA COVERINGS.
Johns-Manville, H. W., Co., New York.

MANILA AND SISAL ROPE—See ROPE; also CORDAGE.

MARINE BOILER COMPOUNDS—See BOILER COMPOUNDS.

MARINE CABLEWAYS.
Lidgerwood Mfg. Co., New York.

MARINE ENGINES—See ENGINES, PROPELLING.

MARINE FORGINGS—See FORGINGS.

MARINE GAS PRODUCERS.
Griscom-Russell Co., New York.
Marine Producer Gas Power Co., New York.

MARINE GLUE.
Ferdinand, L. W., & Co., Boston, Mass.

MARINE HARDWARE.
Griscom-Russell Co., New York.
Ferdinand, L. W., & Co., Boston, Mass.

MARINE LAMPS—See LAMPS.

MARINE RAILWAY BUILDERS—See RAILWAY DRY DOCKS.
Crandall Engineering Co., The, East Boston, Mass.

MARINE RANGES—See RANGES.

MARINE REFRIGERATION—See REFRIGERATING PLANTS.

MARINE SIGNALS—See SIGNALS.

MARINE SUPPLIES.
Ferdinand, L. W., & Co., Boston, Mass.

MASTS, STEEL.
Welin Marine Equipment Co., Long Island City, N. Y.

MECHANICAL DRAFT.
American Blower Co., Detroit, Mich.
Sturtevant Co., B. F., Hyde Park, Mass.

MEGAPHONES—See CHANDLERY STORES.

METAL WORKING TOOLS—See TOOLS, MACHINE.

METALLIC PACKING—Also see PACKING.
Greene, Tweed & Co., New York.
Holmes Metallic Packing Co., Wilkesbarre, Pa.
Johns-Manville, H. W., Co., New York.
Lockwood Mfg. Co., East Boston, Mass.
United States Metallic Packing Co., Philadelphia, Pa.

METRES, ELECTRIC.
General Electric Co., Schenectady, N. Y.
Weston Electrical Instrument Co., Waverly Park, Newark, N. J.

MILLING MACHINES.
Niles-Bement-Pond Co., New York.

MINERAL WOOL—See NON-CONDUCTING COVERING.

MONITOR NOZZLES—See HOSE NOZZLES.

MOORING ENGINES.
American Engineering Co., Philadelphia, Pa.
Hyde Windlass Co., Bath, Maine.

MOTOR BOATS—See LAUNCHES AND YACHTS.

MOTOR BOAT SUPPLIES.
Ferdinand, L. W., & Co., Boston, Mass.

MOTORS, ELECTRIC.
General Electric Co., Schenectady, N. Y.

MOTORS, GASOLINE—See GASOLINE ENGINES.

MULTIPLE DRILLS.
Niles-Bement-Pond Co., New York.

MULTI-SPEED MOTORS.
Stow Mfg. Co., Binghamton, N. Y.

NAUTICAL INSTRUMENTS.
Hand, John E., & Sons Co., Philadelphia, Pa.

NAVAL ARCHITECTS—See PROFESSIONAL CARDS.

NEEDLE VALVES—See VALVES.

NIPPLES.
National Tube Co., Pittsburg, Pa.

NON-CONDUCTING COVERING.
Johns-Manville, H. W., Co., New York.

NOZZLES—See HOSE NOZZLES.

NUTS—See BOLTS AND NUTS.

OAKUM.
Baltimore Oakum Co., Baltimore, Md.
Davey, W. O., & Sons, Jersey City, N. J.
Welin Marine Equipment Co., Long Island City, N. Y.

OIL—See LUBRICANTS.

OIL BURNERS, FUEL—See FUEL OIL BURNERS.

OIL CUPS—See LUBRICATORS.

OIL FUEL APPARATUS.
Schutte & Körting Co., Philadelphia, Pa.

OIL ENGINES—See ENGINES, OIL.

OIL GAUGES.
Lunkenheimer Co., Cincinnati, Ohio.
Powell Co., The, Wm., Cincinnati, Ohio.
Star Brass Mfg. Co., Boston, Mass.

OIL PUMPS.
Lunkenheimer Co., Cincinnati, Ohio.
Star Brass Mfg. Co., Boston, Mass.

OILING SYSTEMS—Also see LUBRICATORS.
Albany Lubricating Co., New York.
Cook's Sons, Adam, New York.
Lunkenheimer Co., Cincinnati, Ohio.
Powell Co., Wm., Cincinnati, Ohio.
Schutte & Körting Co., Philadelphia, Pa.

ORE DOCKS—See DOCKS.

PACKING—Also see METALLIC PACKING.
- Greene, Tweed & Co., New York.
- Holmes Metallic Packing Co., Wilkesbarre, Pa.
- Johns-Manville, H. W., Co., New York.
- Lockwood Mfg. Co., East Boston, Mass.
- Peerless Rubber Mfg. Co., New York.

PACKING, ASBESTOS.
- Johns-Manville, H. W., Co., New York.

PAINT—Also see GRAPHITE; also MARINE PAINT.
- Dixon, Jos., Crucible Co., Jersey City, N. J.

PATENT ATTORNEYS—See ATTORNEYS, PATENT.

PETROL ENGINES—See GASOLINE ENGINES.

PHOSPHOR BRONZE CASTINGS.
- Griscom-Russell Co., New York.
- Hyde Windlass Co., Bath, Maine.
- Lunkenheimer Co., Cincinnati, Ohio.
- Phosphor-Bronze Smelting Co., Philadelphia, Pa.

PILING—STEEL.
- Lackawanna Steel Co., Buffalo, N. Y.

PIPE COVERING—See NON-CONDUCTING COVERING.

PIPE CUTTING AND THREADING MACHINES.
- Niles-Bement-Pond Co., New York.

PIPE FLANGES—See FLANGES.

PIPE UNIONS.
- Dart, E. M., Mfg. Co., Providence, R. I.
- Lunkenheimer Co., Cincinnati, Ohio.
- National Tube Co., Pittsburg, Pa.
- Powell Co., The Wm., Cincinnati, Ohio.
- Williams Valve Co., D. T., Cincinnati, Ohio.

PIPE WRENCHES.
- Williams & Co., J. H., Brooklyn, N. Y.

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